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Glacial Problems in Central New York

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Long deferred studies of this region have been resumed during the past three field seasons. The writer proposes the mapping of an area reaching from the northern parts of the Appalachian Plateau across the upper Mohawk Valley into the southwestern border of the Adirondacks. Six quadrangles are included: Sangerfield, Winfield, Oriskany, Utica, Boonville, and Remsen. Much observation outside of these limits has been necessary. The detailed mapping and a full report on so large a central area, would require so much time that it seemed best to present certain results at the meeting of the Association of American Geographers in Worcester, and they are here given publication.

While the author has not pursued this work under the authority or direction of the State, he has acted in his capacity as a Collaborator of the New York State Museum and this preliminary paper is published with the full approval of Dr. Charles C. Adams, Director of Science.

EARLIER STUDIES IN THIS REGION

Following the shrewd guesses of early travellers like Timothy Dwight and DeWitt Clinton, and the brief descriptions of Vanuxem and Dana, the first constructive interpretation was offered by Chamberlin, in his oft quoted conclusion that a pre-glacial water parting was at Little Falls, and that, in the waning of ice flow across the Adirondacks, there were movements around the mountain mass, that these were lobate in character, that there was a movement westward in the lower Mohawk region, and a

movement to the southeastward from an Ontarian center, down the upper Mohawk as far as Little Falls, 5.¹

In 1897 the writer in a study of the Chenango Valley, 2, described the moraines and terraces of the valley, showing their distribution on a small-scale map. A study of the Mohawk Valley followed in 1898, 3. In this paper it was shown that the Mohawk is a subsequent valley developed on the strike of soft rocks on the northern edge of the Appalachian Plateau: that the ancient consequent drainage was diverted eastward and westward from the col at Little Falls; that the Susquehanna streams were beheaded, and that short obsequent streams of high gradient incised important valleys in the northern edge of the Plateau. It was also shown that the West Canada Creek entered the westward-flowing "Rome River" and that aggradations of glacial waste added the Rome-Little Falls section to the Mohawk discharge. In this paper the author quite fully described the static-water terraces from Rome to Little Falls and inferred therefrom a lake level of about 600 feet in that part of the valley.

In 1904 Fairchild's paper on "Glacial Waters from Oneida to Little Falls," 7, refers chiefly to high level channels, along which glacial waters are held to have had outflow, mainly to the east, between an ice barrier in the valley and the northern slopes of the plateau. These views will be considered in detail in a later section of this paper.

In 1912, 8, Fairchild develops his view of a series of large glacial lakes held in the Mohawk Valley, between opposing ice fronts, with discharges into the Susquehanna and Hudson basins. Fairchild in his "Susquehanna River in New York," 9, 1925, touches our region at several points, to which later reference will be made.

This study is correlated with, and in part flows from the author's "Glacial Geology and Geography of the Lower Mohawk Valley," 4, 1929. The region now under investigation is the more critical in its bearing on the great questions of New York glaciation, but the two have in common the question of glacial movement and retirement and the problem of glacial lakes.

The author has had the advantage of many field conferences with experienced observers. Here he refers in grateful memory to the late Mr. H. O. Beckit, Director of the Oxford University School of Geography. Mr. Beckit was a highly trained physi-

¹To save space, the numbers in boldface type refer to the appropriate papers in the bibliographic list, pages 205-206.

ographer and spent the greater part of two months in the field with the author, in 1929. Appreciative acknowledgment is also made to Col. Lawrence Martin, who has wide knowledge of glaciation through observations in New York, Wisconsin, Alaska and other regions. Also to Professor Harold O. Whitnall of Colgate University, and Professor Nelson C. Dale of Hamilton College, both having had prolonged and intimate knowledge of the region.

PHYSIOGRAPHY OF THE REGION

The map shows the Mohawk from Rome almost to Schenectady. Westward from Rome to Oneida and Oneida Lake is the eastern end of the Iroquois basin. The eastern quadrangles, which were the subject of earlier studies, 4, are included in order that the general relations may be better shown. Southward the map carries us 30 to 40 miles into the Appalachian Plateau, and includes long sections of most of the head streams of the Susquehanna in central and eastern New York. Two of the short, swiftly flowing, obsequent streams, Oneida and Sconondoa Creeks, belong to the Ontarian drainage. Those flowing to the Mohawk are, from west to east, the Oriskany, Sauquoit, Moyer, Gulf, Fulmer and Nowadaga Creeks. Farther east the position of Otsquago Creek may be noted.

The cols will be found at Peterboro, Pratts, or White's Corners, Bouckville, Waterville, Richfield Junction, Dayville, and Cedarville, and, north respectively of Springfield Center, East Springfield, and Cherry Valley.

The land forms about Little Falls are known to physiographers as primarily due to an ancient uplift of crystalline rocks, pre-Cambrian in age. West of that point, culminating in the Deerfield Hills, the rock strata are mainly of soft shales, dipping toward the Mohawk River.

South of the Mohawk is a series of irregular, but quite real escarpments, due to beds of conglomerate, sandstone and limestone, alternating with masses of shale. The geological map of New York may well be consulted. Southeast of Utica in New Hartford and Frankfort, in the heights south of Dutch Hill, also in the slopes above Ilion and Mohawk, the strong beds are of Oneida conglomerate and sandstone and the sandstones of the Clinton formation. Nearly all the striation records within four miles of the Mohawk on the south are on rocks of Oneida age.

The next escarpment is highly irregular, but has long been recognized as a feature of the northern wall of the plateau from

east to west, the ascent over the great limestones. Among the summits and steep hillfronts of these beds we name Prospect Hill, southwest of Hamilton College, Paris Hill and its outlier, Crow Hill, and Babcock Hill east of Sauquoit. Again the limestones rise west and east of the Ilion Gulf, south of Elizabeth, Denison Corners, Starkville and Saltspringville, also in the heights which are cut by the gorge in which lies the village of Sharon Springs.

South of this escarpment is a drumlinized platform of limestone reaching south to the Cherry Valley Turnpike, as at East Springfield, Richfield Springs and Winfield. Above this section of the Turnpike there rise on the south, giant hills of Devonian sandstone. Farther west, between Bridgewater and Sangerfield, a broad and high extension of the sandstone reaches northward and culminates in Tassel Hill.

It is a singular fact that several of the cols between the Mohawk and Susquehanna are not in the zone of high sandstone hills, but are on the limestone platform, from one to four miles north of the Cherry Valley Turnpike.

We may observe that the Mohawk-Iroquois lowland is in a trough running more than 100 miles athwart the main trends of the Laurentian ice; that the plateau is cut by a series of deep north and south valleys; and that the inter-valley belts in the upland are deeply and irregularly dissected into a labyrinth of short valleys and hills. Thus may we see how complicated was the scene for glacial activities and how cautious and prolonged must be any investigations which lead toward assured conclusions.

The scale of the map, Figure 1, permits but a limited total of glacial data to appear. We have included the glacial striations thus far found; the great series of morainic areas leading eastward from the Oneida Valley to Little Falls, also the interlobate moraine in Fulton County.

ICE MOVEMENTS IN CENTRAL NEW YORK

The directions and the changes of movement in New York state as a whole are described in 4, pages 12-15, including the map of the state (Fig. 1). The general direction of movement at the height of glaciation was southwest. This was true in all parts of the state except in the Hudson Valley south of Albany. The Adirondacks, the Catskills and the central and western plateau from Lake Champlain to Lake Erie shared this movement. In-

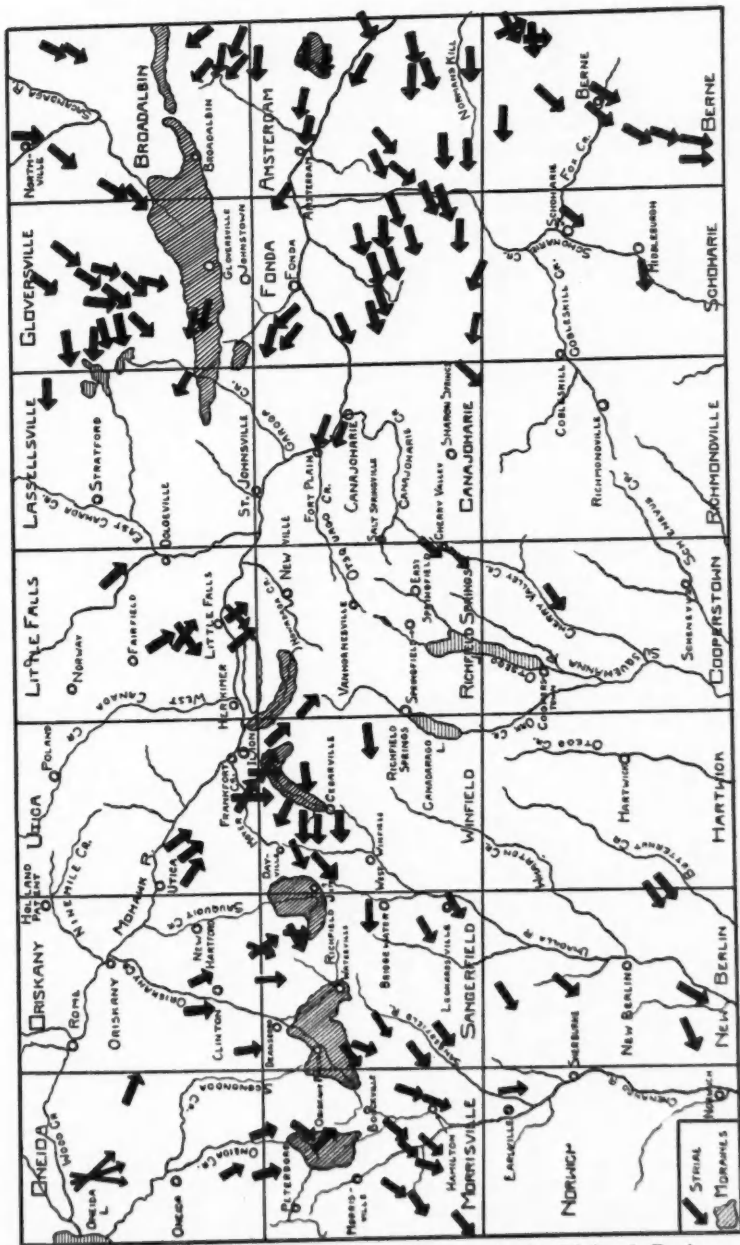


FIG. 1—Glacial Striae and Principal Moraines in the Mohawk Region.

equalities of surface, notable as they are in most of the state, were largely disregarded in this massive flow.

When the ice thinned and its motion weakened, the great valleys and strong elevations came into control and there were local currents and lobate developments. Such was the Champlain-Middle Hudson-Mohawk movement. Likewise a great Ontarian center developed, with a push down the Iroquois-Mohawk valley to Little Falls; through the Black River Valley; and to the south, or even east of south, under control of the Finger Lake valleys of western New York.

Our present query relates to central New York. The change from the culminating, trans-Adirondack control to differentiated lobes on the east, south and west, must have been gradual. When the opposing Mohawk and Ontarian lobes became fully individualized, they found some line or zone of meeting. What were their outer limits and where did they come together? The major land reliefs, the linear topography, the glacial striae and the morainic accumulations must all have a share in the answer.

NEW DATA ON THE MOHAWK LOBE

Reference to 4, pages 36-41, will be found useful in this connection. The striae and the drumlinoid forms along the lower Mohawk tell a conclusive story. The linear features with the resulting east by west alignment of most minor streams, continue across the Canajoharie and Richfield and the eastern part of the Winfield quadrangles. In the last, at South Columbia, is the graving seen by Chamberlin nearly 50 years ago and by him regarded as decisive of western movement. Thus far in our study, striae have been mainly sought west of the meridian of Richfield Springs and south of the Mohawk River. A glance at the accompanying map shows that the westerly movement prevailed throughout the northern half of the Winfield quadrangle. The gravings of the arrows that point westerly are all on limestone.

In the northwestern quarter of the Winfield quadrangle the prevalence of east by west drumloid forms ceases and it was thought that there must have been the western limit of the Mohawk ice. This seemed the more probable, as the strong limestone ridge of Babcock Hill here protrudes northward. West of Babcock Hill is the Sauquoit Valley, here clogged with washed drift of morainic heaps and showing ice contacts along the stream. But on the high slopes to the west of the village of Clayville, is what appears to be a morainic area of shoved till, and westward

on the high limestone platform of the towns of Paris and Marshall are drumlins, a dozen or more, with east-west axes. The striae located among them point southwest and south and appear to antedate the light overriding which made the drumlins.

We also find in the sandstone highlands, three miles west of Bridgewater village, at an altitude of 1660 feet, a graving pointing due west. This may record a very local movement, but it is significant that both this and the drumlins are 14 miles farther west than Chamberlin's graving record at South Columbia, and would seem to carry the westward movement a little beyond the meridian of Utica and at a distance of 10 to 15 miles south of that city.

THE ONTARIAN LOBE

Before turning to the subject of this section, it will be well to observe the record of striae in the Sangerfield, Morrisville and New Berlin quadrangles. The whole area is a typical part of the plateau, cut by deep valleys of a nearly north and south trend. Except in the northern parts of the Sangerfield and Morrisville areas the gravings depart little from a southwest direction and are commonly divergent from the course of the main valleys. In exceptional cases the striae fall in with the valley axes. Virtually all of these represent the dominant movement across the state and were made earlier than those of the Mohawk and Ontarian flows.

It is now desirable for the reader to mark the position and alignment of those great bodies of moraine most of which occupy obsequent valleys. Beginning on the west they are as follows: the Pratts-Munnsville moraine, filling the broad Oneida Valley for several miles northward from the col. The Oriskany Falls moraine reaching eight miles from Madison and Solsville nearly to Deansboro. The Waterville moraine branching from the Oriskany Falls mass and occupying the valley of the east branch of the Oriskany Creek; and the Sauquoit Valley moraine, filling that valley for about seven miles. All these moraines end northward eight to ten miles before their valleys open on the Oneida-Mohawk lowland.

We further notice the moraine above Ilion, which clogs the valleys of Gulf Stream and Steel's Creek; the moraine which occupies the valley of Fulmer Creek from the village of Mohawk nearly six miles toward Paine's Hollow; and lastly the massive belt of moraine on the south side of the Mohawk Valley from Fort Herkimer toward Little Falls.

It is now important to observe that nearly all the striae which can be ascribed to the Mohawk lobe are south of this morainic belt. In like manner the earlier striae pointing to the southwest are south of the line of moraines. All the Ontarian gravings thus far found, with two possible exceptions, lie north of the morainic belt.

In the region where the Oneida and Oriskany quadrangles join on the south the Morrisville and Sangerfield quadrangles, the striae in the main point a little east of south. Taking account of the magnetic variation, a few would be directed due south. Of two records near Clinton given to the writer by Dr. Nelson C. Dale, that on Hamilton College Hill is of this group, and together the south-pointing striae seem to represent a prolonged early movement of Ontarian ice which must have contributed largely to the vast moraines in the more westerly valleys.

The striae in or near the valley lowland, have generally a southeastward trend and represent a later and more restricted flow along the axis of the Oneida-Mohawk trough. Here we note a graving, on Oneida conglomerate, nearly midway between Oneida and Rome, and several on Frankfort Hill and Dutch Hill. About three miles southwesterly from Ilion, well up on the hill slopes of the Mohawk, are two localities where striae cross each other. The marks are on sandstone. The older gravings run in a southward direction. The others, which cut across the first and are unmistakably later, trend southeast and east.

One hesitates to say whether the south-pointing lines are Ontarian or a variation of the great earlier sweep across the state, but the later markings are clearly the work of a Mohawk extension from the Ontarian center. It seems natural that the thrust of this upper Mohawk ice should fill the valley of Fulmer Creek and hence we believe that the two records, south and southeast of Mohawk village, belong to the Ontarian rather than the lower Mohawk lobe. The more easterly graving, which is in the Richfield quadrangle, is on a ledge of quartzitic sandstone on which the plucking seems to have been accomplished by ice moving toward the east.

More than thirty years ago, Mr. G. K. Gilbert, in a letter to the writer, referred to the possible meeting of east and west currents of ice between Richfield Springs and Syracuse, and to the apparent nonexistence of any double-faced moraine which might have been expected. We do indeed find the great valley-head moraines between the two movements, but they are not double-

faced. We follow the Ontarian lobe securely to Little Falls and perhaps over the block of hills between Little Falls and Newville. In like manner we safely locate the western extension of Mohawk glaciation in the north half of the Winfield quadrangle, and with a lesser degree of assurance, as far west as Paris and Bridgewater.

Between the Mohawk Valley southeast of Utica and the Winfield basin is a ridge of hills culminating at more than 1700 feet. Here seems to have been a topographic control between the two narrowing lobes. Two wedge-like bodies of ice pointing, one westward and the other eastward, appear to have existed. The two lobes did not clash, head on, as has been supposed, in the middle part of the Mohawk valley, but they slid by each other along, and south of, the upper part of the great trough. It remains to see whether more detailed studies can locate a close boundary. There may well have been alternating encroachments by one ice stream or the other, and zones of stagnation, which will leave us always short of precision.

THE COLS AT THE HEAD OF SUSQUEHANNA WATERS

Ten of these in our field deserve attention. Knowledge of them will aid in studying the retirement of the ice and the movements of glacial waters. As the accompanying map is too small to give more than location, the reader should have at hand the Morrisville, Sangerfield, Winfield, Richfield Springs and Canajoharie sheets, and, lying to the south, those of the Norwich, New Berlin, Hartwick and Cooperstown quadrangles. From west to east the cols are as follows:

1. Peterboro village is on a branch of the Oneida Creek. There is no significant opening in the low hills to the southward, but there rises the main headwater of the Chenango River. The important fact is that for many miles southward, past Morrisville, Eaton and Earlville, the valley is comparatively free from massive or bunched drift.

2. White's Corners, $1\frac{1}{2}$ miles north of Morrisville Station. Here was the outflow from the great glacier of the Oneida Valley. White's Corners spillway is on the west side of the valley, whose whole width, $1\frac{1}{2}$ miles, no doubt shared the direct discharge from the glacier, for the entire valley is filled with pitted outwash. This passes into the moraine belt south of Morrisville Station. The altitude is about 1100 feet. The depth of the drift is unknown.

3. Bouckville, altitude close to 1150 feet. Two miles north-

east, toward Solsville, is a strong, well defined spillway, leading out from the great Oriskany Falls moraine belt, between massive delta terraces. The moraine and terraces are described in 2, map and pages 23-24. This valley joins near Pine Woods, that last described and continues past Hamilton to its union with the main Chenango Valley at Randallsville. Moraines, moraine-headed terraces and pitted outwash are its characteristic features.

4. Waterville, altitude about 1250 feet. Here, in an area of low kames, is an indefinite passage between the east branch of the Oriskany Creek and the valley of the Sangerfield River. Sangerfield, 1 mile south of Waterville, is on a lake plain which soon passes into the marshes of the "Long Swamp," which occupies the valley for eight miles south, to Hubbardsville. A glacial tongue filled this section of the valley and built an outwash plain at Hubbardsville. The retirement of the ice left a lake, whose outlet has breached the outwash plain. South of Hubbardsville, for several miles, nearly to the junction with the Chenango Valley at Earlville, this valley is clogged with kame terraces. The freedom from bunched drift in the Long-Swamp section is notable.

5. Richfield Junction, altitude about 1260 feet. Here is a broad valley plain which long received the discharge from the great glacier which pushed up the Sauquoit valley as an extension of the ice sheet which lay to the north. The valley south of the col now carries the small west branch of the Unadilla River. It should now be observed that cols 2 to 5, the White's Corners, Bouckville, Waterville and Richfield Junction are all in wide troughs and over an unknown depth of drift filling. The cols are as spacious as the beheaded valleys southward or the valleys northward. They are true "through-valleys" and their history offers a difficult and interesting problem. There is evidence of some shifting of divides through glacial accumulation and important evidence will be found in the thick underlying lacustrine clays of the Chenango Valley. These were briefly described in 2, pages 27-30.

6. Dayville. A minor, but well developed passage between Moyer Creek on the north and the North Winfield Creek, which joins the Unadilla River at West Winfield. The altitude is 1337 feet.

7. Cedarville. At this village and southward is the col which passes from the moraine-crowded Ilion Gorge (Gulf, on the topographic map) to the headwaters of the Unadilla River (East Branch). The altitude is 1220 feet. Southward from Richfield

Junction and Cedarville, past the junction of the two valleys and to a point south of Leonardsville there is little bunched drift in the valley. From that point southward for many miles the Unadilla valley is broadly occupied in many sections with kame terraces, and with deltas whose materials came from tributary valleys. The evidences of stagnation are conclusive. The col at Cedarville is narrow, and the limestone base but slightly mantled with drift.

8. Summit Lake. This lake is a little south of the actual divide between Susquehanna (Otsego) headwaters, and the Otsquago Valley which joins that of the Mohawk at Fort Plain. It is between Springfield Center and Vanhornesville. The actual col is morainic from side to side. The valley southward to Otsego Lake is not actually floored with limestone, save in trifling exposures, though the drift cover is thin. The altitude is 1360 feet. There is little bunched drift and for many miles the valley is occupied by Otsego Lake, at whose foot is Cooperstown. Impressive evidence of stagnation begins to appear south of Cooperstown and continues southward for many miles toward Oneonta.

9. East Springfield. Two miles north is a divide at 1420 feet, between the valley of Shadow Brook and the head of Canajoharie Creek at Saltspringville.

10. Cherry Valley. The col north of the village, at the head of Cherry Valley Creek leads across to a small affluent of Canajoharie Creek. The significant fact in our present study is not the divide, which is a small feature, but the fact that Cherry Valley has little drift except ground moraine for about ten miles from the col. Then, about Middlefield, begins the evidence of stagnant ice to the junction of the valley with that of the Susquehanna River.

It may now be observed that in the last four cols the surfaces are close to the limestone. They are not broad and deeply cut, through valleys. Their character and history differ much from most of those lying farther to the west.

THIN DRIFT ON THE LIMESTONE BELT

We have seen that the limestones offer a dissected but true escarpment from the Hudson Valley far westward. South of the escarpment a limestone platform some miles in width, leads southward to the base of the great hills of Devonian sandstone.

The belt is a zone of thin drift. This appears commonly along the Cherry Valley Turnpike from the Fonda and Schoharie quadrangles westward to West Winfield. The same is true even in the heavily drumlinized tract in the Richfield Springs and Winfield quadrangles. The drift is of some depth in many, perhaps most of these hills, but exposures of the limestone floor are very common among the drumlins. There are examples of what look otherwise like good drumlins, but a section shows rock with a till veneer. Drift is thin on the Babcock Hill extension and on the great limestone platform on which are large parts of the townships of Paris and Marshall in Oneida County.

The glacial paring of the limestone seems to have been effective and vast in amount. Far along the valleys and on the hills of the sandstone plateau, limestone boulders are common and solution of limestone flour has brought about cementation in the gravels and made "hard" the water of wells, springs and ponds.

This transfer of calcareous matter was made in the prolonged sweep of the ice flow toward the south and southwest. When this flow waned, the vigorous Mohawk glacier, plowed, plucked and scraped effectively as it moved westward along the strike of the beds. We may confidently suppose that the limestones, long exposed in the shaping of the great cuesta, were honeycombed and made cavernous all along the belt of outcrop. This condition would have facilitated plucking and removal when the ice invaded the belt. Many of the drumlins, when cut along the line of highways, show an astonishing profusion of glaciated limestone boulders.

These facts have a bearing on an interpretation of the eastern cols. Thin drift, or even bare limestone, does not necessarily mean excessive removal by the waters that may have flowed over and from them. Active glacier tongues, projecting from the deep ice of the Mohawk trough, doubtless rimmed out these cols and removed drift from their floors. A moderate amount of water escaping from the melting ice, is perhaps all that can be postulated from the condition of the cols as they appear today.

RETIREMENT OF THE ICE FROM THE PLATEAU

In a region of complicated topography and strong relief, it is difficult to learn the precise stages of ablation. The extent of stagnation is subject to wide differences of opinion, but in our region it certainly was not small. The search for marginal or terminal accumulations often ends in failure to find them. The

sources of supply were various and no doubt changed by slow gradation in their relative efficiency.

West of the lower Mohawk no quadrangle in New York has been mapped in detail with publication, save those done by Tarr in the Watkins-Cattatonk region. In the quadrangles of the state, about 230 in number, there is needed much detailed study of Pleistocene conditions. It is to be regretted if in the economic demands on geology, there should not be a return to glacial studies.

There is reason to think that the ice was thicker, that it remained longer and ground harder on the northern than the southern parts of the plateau. Madison County for example shows in its great rock hills more of drumloidal shaping than appears in Chenango or Broome County. This whole upland is rather even in its general altitudes and the gradients of the Susquehanna head streams south of the cols are all low.

We must combine a push from the thicker ice masses on the north, with abundant local precipitation in order to see the possibility of a sweep across the rugged topography to the Pennsylvania line and beyond.

In our account of the cols it has been shown that, south of certain points there was in all the valleys much stagnation. The whole region awaits detailed study but the fact stated is confirmed by map and field observation. When the ice ceased to be able to cross the innumerable ups and downs of the plateau surface, it might still move southward in the greater valleys. But one could not expect narrow ice tongues to protrude actively from the main ice sheet 40 or 50 miles. The valleys immediately south of the cols are free, or nearly free, from special accumulations. We believe that these sections of the valleys were occupied by active ice tongues and that these disappeared rapidly when the northern supply weakened. When the thinner ice south of the cols disappeared, the live ice could effectively project itself from the main sheet only in the deep obsequent valleys north of the cols.

This is at least a generalization worthy of testing. Cherry Valley keeps its open character for about 10 miles and the Otsego Valley about 12 miles. Here we note that the valley from the col to Springfield Center is narrow, while the Otsego basin is wide. The west-flowing Mohawk glacier held sway as far south as Springfield Center and was competent, in axi-radiant fashion, to project an active tongue through the basin of Otsego Lake.

We have not the evidence to show whether that basin is due to glacial erosion, or to glacial accumulations on the south, or to

both these causes. At any rate it was kept open, it gives no evidence of having held stagnant ice, and it is flanked, especially on the east, by high, steep and smooth slopes suggestive of over-deepening by the ice tongue in the valley.

Richfield Springs is at the south edge of the field of the Mohawk glacier and southward of the village extends Canadarago Lake for four miles and then four miles more of open valley along Oak Creek. The conditions are the same as in the Otsego Valley except that there is no col, only a network of small streams among the drumlins lying on the north.

The valleys at the head of the Unadilla are broad and open, but hold no lakes. There are some striking examples of over-steepened slopes, obviously due to glacial plowing. They are notable on the west side of that great outlier of sandy shales which lies northwest of West Winfield. Fork Mountain, above Unadilla Forks, has a steep west front with an upper slope of 60° to 70° . One mile south of Leonardsville, on the west side, an arrow on our map indicated glacial striation. On a flat shelf 15 feet above the road, is exposed for quarrying, a quarter of an acre of remarkable graving on the flat surfaces and in miniature gorges along joint planes. Even an overhanging wall is well glaciated. Above this shelf, 15 feet, is a like platform, also glaciated and west of this is a castellated cliff with outstanding buttresses of sandstone, accented by the fall of giant joint blocks. Col. Lawrence Martin expressed surprise at finding such cliffs in this region and appropriately applied to the making of them the term "re-craging." Apparently a vigorous ice tongue extending from the glacier of the Sauquoit valley did the work of steepening at several points as noted above.

The Sangerfield Valley south of the moraine has been sufficiently described. South of the Oriskany Falls moraine and of the Oneida Valley moraine about Pratts, the conditions are more complicated and there were certainly successive stands of the retreating ice, as appears from the succession of moraine-headed terraces. Conditions are not clear, from Peterboro southward to Earlville and Sherburne. There is no real col at Peterboro and no well opened passage north of that village. It may be remarked that the Chenango Valley from Peterboro to Sherburne is well aligned with a direct Ontarian outflow. The valley has a massive terrace above its junction with the Hamilton Valley and there are some pronounced morainic masses bordering the valley bottom near Earlville.

Some of these upper valleys held lakes after the melting of the ice opened them. These lakes were held in place by barriers of stagnant ice and accompanying drift lying to the south. At their northern ends they may have laved the ice fronts in their several valleys.

The col at Cedarville at the head of the eastern branch of the Unadilla River is at 1220 feet. The kame terraces and deltas south of Leonardsville are at the same altitude. The Cedarville region, sharing in the general post glacial uprising, may have been 30 feet lower than now in relation to the drift bodies below Leonardsville. We may thus picture a lake 12 to 15 miles long, a mile or more wide and 30 to 40 feet deep.

There is a junction terrace at the confluence of the valleys of Unadilla River and North Winfield Creek. Upon it is a part of the village of West Winfield. Excavations for gravel show pronounced delta structure. In the time of the making of this delta some stagnant ice was present at its head. A lower and larger junction terrace heads between West Winfield and Bridgewater and extends southward toward Unadilla Forks. It was made in slack water which was flanked by flowage in the lake. The flowage was due to the discharge of glacial waters across the cols at Cedarville and Richfield Junction.

There were in the Chenango head valleys, south of Pratts and Bouckville, various lakes of shifting position and size. Into one of these, which must have been long sustained, was discharged the enormous amount of waste which now makes up the delta terraces of Madison, Solsville and Bouckville.

GLACIAL WATER CHANNELS ON THE NORTH SLOPES OF THE PLATEAU

When the ablation of Mohawk ice permitted western waters to find an eastern outlet the mode of their escape becomes a critical question. Did they move on a sedimented cover of high-level, stagnant ice? Did they find release in high channels between the ice and the highlands on the south? Or, did the early lowering of Mohawk-Hudson ice so antedate the disappearance of the Ontarian ice from the Syracuse-Oneida region, that the waters were let down to the conspicuous levels long known to have held place at 600 feet and 460 feet above and below Little Falls?

We know that fossil river channels and cataracts are highly developed south and east of Syracuse. Professor Fairchild has mapped groups of channels eastward to the Oneida Valley. The

writer has given some examination in the field to the maps of this report so far as they relate to the hills above Canastota, and on Stockbridge Hill southwest of Oneida. He is able to recognize as true spillways a few, but by no means all of these alleged channels.

We come now to the region more immediately in the field of this paper, that lying east of Oneida Valley. Professor Fairchild in his "Glacial Waters from Oneida to Little Falls," 7, maps many lines on the northern slopes of the great hills as glacial spillways. Here therefore it becomes necessary for us to take his paper into detailed discussion.

For the convenience of the reader not familiar with central New York local geography, we may note that the outstanding hill fronts are as follows: Eaton Hill between Oneida and Sconodua Valleys; Prospect Hill between Sconodua and Oriskany Valleys; Paris Hill including its outlier, Crow Hill, between Oriskany and Sauquoit Valleys; Forest Hill and the Graffenberg in and southeast of Utica; and Frankfort and Dutch Hills east of Utica. The student should if possible have the Fairchild map, 7, before him.

On Eaton Hill we find the lower slopes in Vernon Shale, and the upper slopes on limestone. The two upper "channels" do not show to the writer any evidence of water cutting. The ordinary modelling by an over-riding glacier accounts for them. The "cataracts" do not respond to the tests which could be applied at Jamesville or Fayetteville. There is a preglacial (or interglacial) recess in the hill side, with a drift cover on the slopes and no exposure of the limestones save in small ledges at the top. No cut channel leads from the west. It would seem certain that a torrential flow into this amphitheater would have wrought conspicuous erosion.

We believe there was a strong outwash just below 1000 feet. The elongated hill on the northwest slope of the main mass has a morainic appearance. On the west side of the Sconodua Valley, where waters at 1000 feet would issue, there are extensive gravel terraces, at 1000 feet, in which delta structure is unmistakable. The delta confirms Fairchild's suggestion of a lake at that level. A mile to the south (Near letter T of Augusta on the Oneida sheet) is a roadside section showing berg till under a terrace level. The matrix is mostly waste from Vernon shale, while the delta gravels above named are of limestone almost entirely. This seems to show that the delta materials came from

the west, and this is in accord with their foreset structure. A part of this delta front shows ice-contact slopes. The lower channel on Eaton Hill is doubtful, for here we have a vigorous wet-weather stream capable, on a slope, of doing much work in the soft shales in recent times. The Hamilton College "scour-way" seems to us inadequate as a line of discharge for the lake waters of the Sconondoa Valley.

Taking up the conditions on Prospect Hill: the depression crossing the hill range, one mile south of the summit (triangulation station) shows no evidence of water action. It is a simple glacial saddle and may be dismissed. North of the summit three channels are mapped as crossing the north and south road. There is no watercutting, there are no cut banks, and there is no gradation. The map leads the symbols eastward to small streams near the Hamilton College waterworks. The work done along these streams is wholly normal to their capacity of accomplishment in post glacial time.

The channel supposed to reach Hamilton College Campus, shows no cutting and is one of those numerous shelves of glacial origin, based on the soft shales that form the foundation of these hills. The ravines on each side of the campus are purely post glacial gorges in soft rocks. The channels along Dean's Creek and the stream passing Lairdsville are recent. One of the physiographers with the writer in the field, made in a similar case the remark that "he had long ceased to think there had not been time for a stream to have done what it seems to have done." Dean's Creek is in no sense an under-fit stream.

We are quite unable to understand Professor Fairchild's statement, 7, page r 25, "All the north-facing slope from Prospect Hill to Lairdsville has been quite denuded of its drift by the stream action and the cut banks and channels are mostly in rock." The writer has been able to find no rock exposures except around the summit of the hill and there the thinness of the drift accords with the conditions already noted on the whole limestone belt. The north slopes of Prospect Hill have the usual mantle of glacial drift.

The trough noted on Crow Hill by Fairchild has on its south side an escarpment of limestone. The floor is highly irregular and is made of till. The two markings northwest of Crow Hill are purely glacial forms. The long channel at 800 feet, issuing near New Hartford, gives no clear evidence of carrying water and

is another of those very common shelves modeled by glacial action on soft rocks of the Vernon shales and the Clinton group.

We take "Channels South of Utica," 7, r 26, and high on the hills at 1000 feet. Here is absolutely no trace of water action. There is a slight glacial fluting of a till mantle over the Clinton sandstones, which cap the hill at that point. The "cutting" one-half mile north is drawn as if one-half in the valley of Ballou's Creek. It is worthy of note that this small stream has cut a profound gorge through a conglomerate cover into the shales in postglacial time. And it is equally instructive in interpretations of this sort to observe that this creek made the "Gulf" west of third street in Utica, a broad flat bottomed channel 40 feet deep.

Repeated observations along the "channel" south of Forest Hill and issuing at the three reservoirs, fail to show any sign of water passage. There is no cut bank, no gradation and no deposit save the usual bouldery till. As to the lower channel in Utica, there is a low bluff near Genesee Street for a short distance, under the Orphan Asylum and St. Elizabeth's Hospital and then for two miles along the Boulevard and under Proctor Park the till of the hill descends by a normal uncut slope into the broad sag in which the southern parts of the city mainly lie. There is positively no stream work.

Coming to Frankfort Hill, we are again puzzled by the words, 7, r 27, "The whole north face, some three miles in breadth, is denuded of drift." Not to dwell overlong on details it is wholly fair to say that the evidence of water cutting is not present. The "most conspicuous bluff" at 1000 feet is produced by the outcropping of a thick bed of Oneida Conglomerate. The cliff has been accentuated by the quarrying, 40 and 50 years ago, of foundation material for Utica and the piles of quarry rubbish on this glacial platform are now grown to youthful forest.

Reference is made to an eastward extension of the Frankfort Hill south of Center. "Conspicuous cut banks have been seen" etc., 7, r 27. When seen on the ground these banks are found to be the inevitably outstanding ledges of Oneida sandstone.

Again, in reference to Dutch Hill we meet the surprising statement, 7, r 28, "No glacial drift remains on the slopes, which are Utica shale." Beginning at the top, the "two small stream cuttings" on the beginning of the south slope, over Center, are not due to stream work save a trifling erosion in one by an existing brook. The other is the south side of a drumloid, glacially

carved out of sandy shale. The benches seen on the upper west slopes of Dutch Hill are ordinary glacial flutings. The rather striking photograph in Fairchild's plate 8 would present an entirely different appearance if taken in line with the cliff which shades into an uncut slope descending northward. At the east end (the left) the bench ends in a depression of the hill, glacially banked with till and big boulders. If here had been a real channel with any considerable flow, a cataract at this point should have cut away the drift.

There is a substantial cover of drift on the whole slope. There are no long middle channels. That this map cannot conform to the facts would appear from the descent of the spillway symbol down 200 feet of contour, and that toward the west. There is no channel here—only a uniform steep slope and nearer the base is a massive, sloping, uncut bench of till leading down to the canal and railway.

Professor Fairchild comments on "the difference between the profiles of Dutch Hill and the steep hill across the river from Frankfort. The map contours represent the latter slope quite correctly as a steep and fairly uniform slope. It was not cut and terraced by glacial streams like Frankfort and Dutch Hills." Here we must note that the contrast is normal to the structure. On the north are soft rocks, whose dip is with the slope. On the south are hard beds alternating with the soft, affording benches and shelves along their strike.

Taking the northfacing slopes as a whole, they afford examples of that glacial benching and fluting which are the constant feature of hillsides in the plateau, whether those slopes face north, south, east, or west. It was remarked by a physiographer in the field, "If these are channels there are a thousand others just as good." This applies to innumerable rock benches veneered with till, and to overridden and fluted masses of till.

Professor J. L. Rich notes the features of glacial channels and summarizes thus: "Glacial channels are easily recognized. They are characteristically flat-bottomed and are usually swamps. The banks in almost all cases are distinct and, except where disturbed by civilization, show little effect of post glacial degradation." We may accept this statement, while seeking to make every allowance for rapid change before a forest cover protected the surfaces, after ablation.

In this discussion it appears that surprisingly divergent opinions

are held about the same features. The details have been presented in no spirit of controversy. It would not be proper to offer a general negative. A statement of evidence as seen by the writer is necessary, so that any interested observer may cover the field and decide for himself.

THE PROBLEM OF GLACIAL LAKES

It has long been assumed that an ice front, receding behind a watershed, gives origin to glacial lakes. This principle has been supported by much evidence. The evidence consists of fossil shore lines, correlating with spillways, delta plains and wide-spread lacustrine sediments. The glacial Lake Agassiz has become a classic example. If all or most of the above conditions are clearly present the case becomes strong. It is assumed that the ice has receded by progressive stages and when these stages are recorded by morainic belts or lous the whole body of evidence may amount to a demonstration.

If a lake is postulated, we therefore look for shorelines, outlets of proper altitude and character, static-water deposits reasonably correlated, lake sediments and recessional moraines. The irregularities of ice recession in a region of strong relief are pronounced. Water bodies may be shifting and temporary. We may be confident of the existence of a lake without finding all the evidences named above. We must adjudge carefully the evidences that appear and as fully as possible account for the absence of those that do not appear. We must not give too much credence to general topographic conditions or to modes of ice ablation which would seem to require the presence of a lake.

The presence of lakes in valley sections south of the cols is highly probable, as already set forth. Did such narrow and elongated lakes fill the obsequent valleys north of the cols? Chamberlin, making his reconnaissance in our region long ago, assumed the necessity of such lakes. In his view and in the general view, there was and must have been a progressive migration of the ice from northward. If great ice masses in the Oneida-Mohawk lowland made it impossible for the waters to escape over or under the ice, they must have had outlet across the cols. In 7 Professor Fairchild describes such lakes as follows: Cowaselon Lake, west of Stockbridge Hill. Stockbridge Lake in the Oneida Valley; Oriskany Lake and Sauquoit Lake.

We seem to be left in some doubt as to Fairchild's final opinion,

for many years later, 9, page 81, in listing the cols, he says, "Of these nine passes across the divide between the Mohawk and Susquehanna waters, the only ones which carried a free stream from open lake on the Mohawk side are the small Cherry Valley and the capacious Cedarville." If he would consider the above named waters as "open lake" on the Mohawk side, this later statement would seem to take them out of consideration.

After many years of observation of most of these valleys, there seems to the writer to be little evidence of such lakes. The work done on the cols is amply accounted for by the outflow of water from the melting glaciers. These glacier tongues did not abruptly or in any short period melt away, leaving a great ice barrier blocking the lowland on the north. They were actively protruded into the valley for a very long period of time. A body of kames and pitted outwash in the Oriskany Valley which is two miles wide and eight miles long, which almost fills the valley from side to side and has unknown depth, calls for an immense lapse of time. Though their areas are smaller, the facts in the Oneida and Sauquoit Valleys are equally impressive. Shoving and melting, deposition and readjustment followed a long course of irregular alternations and successions.

No doubt there were many lakes but they were small and evanescent. All the sections opened during a period of many years show the conditions of typical kames. It seems necessary to believe on such evidence of the progress of recession as we have, that the Ontarian ice was long massive and active, after the Mohawk ice had mainly gone. Thus perhaps we double the demand which the Ontarian ice makes on time. When the ice tongues in the Oriskany and other valleys finally stagnated and melted away they left many miles of ice-contact slopes in the several valleys. The ancient rock valleys were almost filled from side to side with aqueo-glacial waste and through the narrow and crooked lanes left between these steep slopes pass the streams and roadways of today.

DID LARGE GLACIAL LAKES OCCUPY THE MOHAWK VALLEY?

This problem was discussed at some length by the writer in his "Glacial Geology of the Lower Mohawk Valley," 4, pages 72-82. It was there shown that there are no recessional moraines of a retreating Mohawk-Hudsonian ice lobe protruding far into the Mohawk Valley. Such a lobe is mapped by Fairchild in 8, plate

8. He postulates such a glacier extending to Fort Plain or a little above that point.

It was also shown by the writer that deposits made in the Sacandaga region do not belong to large lakes but were made in strictly local waters, and that the characters of the Delanson col do not warrant the conclusion that it was a point of discharge for large waters. It further appeared that the entire hill region south of the Mohawk was extraordinarily free not only from moraines but from beach lines or deltaic deposits.

In this paper we shall deal with the same general problem in the light of earlier and of recent studies in the upper Mohawk Valley. The existence of great water bodies in the valley requires the presence of opposing ice fronts, correlating in time. If we found demonstrative evidence of such lakes in shorelines, in deltas, bars and spits, in bottom sediments and in outlets, we might believe in an ice dam on the east. If we do not find convincing evidence in the field, we cannot assume the presence of lakes on the basis of a theory of ice recession.

We have now seen that the northern slopes of the plateau from Prospect Hill eastward did not carry glacial drainage at high levels. The benches south of Little Falls referred to by Fairchild, 8, pages 25-26, will be discussed later. Thus we know that the waters which crossed the plateau south of Syracuse went freely eastward at relatively low levels as soon as they passed the meridian of Rome.

Professor Fairchild himself holds to the earlier disappearance of the Hudson-Mohawk ice and justly argues that Ontarian ice had a wider and more direct course and therefore a better chance to survive than Mohawk ice, 8, pages 21, 22. Mr. John H. Cook in like manner assumes the earlier departure of the Hudson-Mohawk glacier, for he has sand blowing in the Hudson Valley, "probably under the force of strong northwest winds coming off the land ice in the Ontario basin." (Geol. of Capital Dist., Bul. 285, N. Y. State Mus. 198).

It is necessary to refer to Fairchild's view that the two ice tongues melting "somewhere in the Utica-Little Falls district" would afford a place of weakness and "would probably be the place of separation." This conclusion he enforces by referring to the drumlin areas of the Richfield and Winfield quadrangles as showing weak ice action. Here we must note that recent study carries the Mohawk movement and the drumlin-making farther

west than the Utica meridian, that the Mohawk and Ontarian lobes slid by each other on high ground with no head-on collision, and that the areas of actual drumlins are small. If the ice there gave away, the altitudes are above the alleged water zone in the Mohawk Valley. The valley was full of ice in the long period of culminating southwest flow, and these later currents pushed into wide fields of stagnating ice as the flow from the northeast weakened. A melting apart of two lobes does not seem clearly supported by the argument from the drumlins.

Herkimer Lake of Fairchild, 8, pages 22-26. This name was given to a body of water held to have been developed largely in Herkimer County and supposed to have reached from Utica to Johnstown. Fairchild's map is in 8, plate 8. Large sand plains, 1300 to 1440 feet in altitude, lie where the Black River and West Canada Creek issue from the Adirondacks. These are thought to be deposits in Lake Herkimer, having an outlet first by the Summit or Otsego col at 1360 feet, and later and chiefly by the Cedarville col at 1220 feet.

The former pass, after repeated examination, does not impress the writer as a spillway which carried more than a moderate outflow, and that from the edge of the waning Mohawk lobe. The actual col is morainic from side to side, there is but trifling exposure of the limestone bed, and the "singular heaps and knolls of limestone rubbish" were not "piled by plunging or cascading waters." They appear in one small field as heaps of quarry refuse, where the opening, long ago abandoned, required the stripping of a heavy cover of till.

Professor Fairchild holds that we cannot separate here between Adirondack waters escaping across ice, and the waters of the higher lake stage. As already noted, the later paper on the Susquehanna River does not include this col as an outlet of lake waters.

The Cedarville col does not suggest the passage of a large and long sustained stream. Yet this is required if it took waters from a great lake and from large sections of the Adirondack region, in a time of extensive ablation. Such a lake should have made beach lines on the hill slopes on either side of the Ilion Gorge and along the adjacent Mohawk slopes. Diligent search has failed to reveal any such evidence of the presence of large static waters. The slopes are perfect examples of smooth, glacial modelling.

Of the Herkimer sand plains it is said that they will be found in many districts, 8, page 24 and plate 2, but none are cited except those of the Black River and West Canada Creek region, and a few small areas north of Stratford. "They will not occur in strength on the south side of the Mohawk valley." Here it is claimed that the streams are short and weak. We are however unable to see in "the slope steep and the strata shale," a reason why abundant debris should not be deposited in the lake. The process would have been aided by the lack of forest cover on wide areas of hillside drift. "The evidence of standing water at high levels throughout the Mohawk basin are abundant and conclusive." This is not true on the south slopes of the valley. "In hundreds of localities . . . we find silted hollows and sandy stretches." This is so general as to be unconvincing. Professor Fairchild referring to slopes below 1200 feet, speaks of the "peculiar softness or smoothness of outline characteristic of wave washed slopes." We are obliged to note that the slopes farther west where ice was supposed to be in the time of the Cedarville outlet, are quite as smooth and flowing as those farther east. If a great lake was present and its shores washed at least 40 miles of the north facing slope of the Mohawk, it seems proper to expect clear cases of shore cutting and offshore deposition.

We turn now to the high-level benches on the slopes southwest of Little Falls, at about 1300 feet and below. Professor Fairchild recognizes, 8, pages 25-26, that he had earlier attributed these features to marginal drainage, but now interprets them as shore features. He says, "It would seem that the northwest winds were here able to produce wave and current work that was effective in carving the soft shales." This might well be true but if true here, why not true on longer and more exposed shorelines reaching far to the west and far to the east?

The following field note made here by the writer many years ago may be useful.

"Five or six great benches appear running south of east from the top of the moraine to the highest point reached. In width they vary from 6 to 15 rods sloping but slightly from the bottom of one escarpment to the top of the next. The escarpments were not measured for slopes but they ran I think from 12° to 30° . They are not horizontal in linear extension but drop off at the ends more or less. There is nothing like uniform extension east or west of the half mile of slope where they are found, though

faint benching is seen. No silt or gravel was seen, only a slight mantle of ordinary till (presumably)—no good exposure of any depth.

"Observed from across the valley, the benches on the south lack considerably of horizontality, sloping mostly to the west. The top of this section of the hill range is roughly drumloid E x W and the benches round over, especially to the west, the stoss side if a glacier were moving down the valley. They fade out decidedly on the east where there is no reason for it if they were beaches."

The writer's conclusion at that time was that the benches are an example of glacial fluting. A recent careful examination gives no reason to modify this view. The benches are on the face of local spurs made by preglacial valleys dissecting the great slope. They are strongly drumlinoid at both ends and almost everywhere depart from horizontality. There is no beach gravel, but only typical till. There are no spits or bars, and there is no extension of the benches along the hillsides to the west. It is not to be supposed that lake waters could have made strong benches at a half dozen different horizons without such extension. The end of a still vigorous Ontarian lobe was pushing southeastward toward the Newville valley and would scrub powerfully on the hill spurs at this point. Of the same nature are the benches on the slopes of the valley west of Newville. These features are of wide distribution in the entire plateau region.

GLACIAL LAKE SCHOHARIE

This body of water is postulated by Fairchild as extending through most of the Mohawk Valley and having outlet by the Schoharie Valley and the Delanson col in the northern part of the Berne quadrangle. With this outlet Fairchild correlates sand terraces south of Devereux and Stratford on the East Canada Creek, 8, plate 7. The tops of these bodies of drift are at 1060 to 1100 feet and in small areas as mapped by Fairchild above 1100 feet. These are correlated with the reputed outlet at Delanson at 870 feet. Differentiated uplift might reduce the discrepancy by 40 feet. Professor Fairchild would account for the greater altitude by an earlier discharge along the Helderberg scarp in the Hudson Valley. The writer has been unable to recognize such scourways in that locality. In the light of the earlier disappearance of the Hudsonian ice, and in consideration of the possibilities of drainage across stagnant ice, we find it difficult to accept "such ice-border drainage" as "a positive necessity."

The plots mapped by Fairchild in the valley of East Canada Creek as deltas of the Herkimer and Schoharie lakes are nearly all, either areas of hilly and bouldery moraine, or local sand plains. The latter are bordered by steep, ice-contact slopes and could not have been deposited in open waters. Cushing's diagnosis still holds true, "they represent merely very local and rather rapidly shifting water levels," attributed by Cushing to a shrinking Mohawk glacier with local lakes on the edge. (Geol. of Vicinity of Little Falls, N. Y. State Mus. Bul. 160, pp. 75-76.)

The deposits in Sacandaga Valley ascribed to Lake Schoharie have been shown by the writer to belong wholly to local waters, 4. The only other deposits mapped or described by Fairchild as belonging to Lake Schoharie are near Trenton, Prospect, Hinkley, and another smaller area five miles northwest of North Western on the upper Mohawk, 8, plate 2. The altitudes respectively are 1000 feet, 1060 feet, 1228 feet and 940 feet. We are doubtful of assigning these deposits to a lake having an outlet 65 and 75 miles away at Delanson. That col shows no evidence of stream passage, and has an altitude of 870 feet. Mr. John H. Cook, 6, who has mapped the Berne quadrangle, rules out the outlet of such "ponded waters from the Schoharie Valley." The sand plains in the basin of West Canada Creek were deposited in the presence of the waning Ontarian lobe. In some cases the plains terminate southward in very steep ice-contact slopes. Such bodies of drift could not have been built in wide and open waters. To sum up we do not find suitable correlation, a true outlet, or any corroborating evidence of shore line work on the long northfacing slopes of the Mohawk Valley.

GLACIAL LAKE AMSTERDAM

Fairchild's account of this alleged lake is found in 8, pages 29-31; see also plate 2. It will be useful to cite here localities and altitudes north and northwest of Utica, where many areas are mapped as belonging to Amsterdam waters.

From a point near Steuben to Westernville and thence beyond Hillside; 860, 880, 820, 860, 850.

From Holland Patent to Mohawk River (Delta of Nine Mile Creek) 520, 560, 580, 520.

From Floyd past Ridge Mills and Delta to Lee Center, 600, 480, 520, 600.

From Lee Center to Taberg, 800, but drops to 500 2 miles south of Taberg.

West of Taberg 700, 600.

Here is a range of 480 to 880 feet. In the passage cited, page 30, the highest Amsterdam level is put at 900 feet and the lowest at 420. This increases the range of variant and declining altitudes of the lake surface to 480 feet. It is to be observed that Fairchild's lowest level is considerably below his highest Iroquois level. Such a range of altitudes for remote and disconnected areas, seems to have little meaning. This is true even granting fluctuations of an ice dam along the lower Mohawk.

The only other Lake Amsterdam deposits mapped by Professor Fairchild are more than 50 miles eastward along the Sacandaga, and these as has been shown, 4, are fully explained by local conditions. It is stated, 8, page 30, that Amsterdam plains occur on East Creek from 800 feet down and at Johnstown at about 700 feet but no other data are given. The entire range of slopes south of the Mohawk River from Rome eastward does not receive notice, although they should show ample evidence if such waters existed. Finally the conspicuous plains at low levels, described by the writer in 3, pages 194-207, are named. If there was anything which should be called an Amsterdam Lake it is marked by the 440-460 foot levels from Little Falls to a point below Amsterdam.

In this study the writer by no means claims that he may not have overlooked or misread evidence favorable to the existence of large lakes in the Mohawk Valley. It seems to him that the facts so far at hand are too fragmentary and too susceptible of other explanation, safely to support so large a conclusion. It is much to be desired that the whole region be subjected to an areal survey and detailed mapping. It is needed to follow the principle thus formulated by Henri Berr,—“Before generalizing it is necessary to particularize.”

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Field Mapping of Residential Areas in Metropolitan Chicago

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THE STATUS OF URBAN RESIDENTIAL STUDIES

A high proportion of the occupied area in every large American city is utilized for residential purposes. This type of land occupancy occurs for the most part in definite districts that differ markedly in character one from another.

The distribution of many of the features which give residential districts their individuality can be shown more effectively by means of maps than by any other device. Not a few of these features are commonly recorded on several types of maps now in use. Standard large-scale topographic maps of cities, for example, show not only the street plan which divides residential districts into "blocks," but they also reveal something of the ground size and spacing of buildings. The latter facts are of necessity more or less concealed by generalization on all except very large scale maps, and in some cases the topographic map alone does not make it possible to determine whether or not a given section of a city is residential, in part or in entirety. Maps prepared by city planning commissions show facts as to size and type of buildings in residential areas. Large-scale maps, published and revised at frequent intervals by the Sanborn Map Company, give rather full details as to materials out of which buildings are constructed, as well as other information of special utility to real estate dealers and insurance companies. Maps exhibiting urban land values have been prepared by economists, and there exist for most municipalities maps which show land ownership. City maps made by sociologists reveal the distribution of various population elements, as well as the spread of selected social traits. Numerous maps of cities also have been made by geographers, showing among other things the location and extent of areas occupied for residential purposes, the spacing of structures within such areas, whether "close" or "open," the type of structures, whether single houses or apartment buildings, and the quality of the dwelling quarters afforded, whether "high," "medium," or "low."

In spite of the importance of residential land occupancy as an element in the distinctive character of cities, this type of urban land utilization has hardly received the attention it deserves, especially in its cartographic aspects. An inspection of urban studies published in recent years by geographers reveals an increasing attention to cities, but in most of such studies the accompanying maps give relatively few details for residential areas. The writer of this paper, therefore, within the last two years, has directed the attention of several groups of advanced students in the Department of Geography of the University of Chicago to the problem of field investigation of residential areas, particularly field mapping, in Metropolitan Chicago. The aim has been to test out procedures already employed by geographers, as well as to develop new procedures. The experiment still is in progress, but this report on results thus far obtained is made with a view to obtaining constructive suggestions from others interested in the study of cities.

OBJECTIVES OF THIS STUDY

At the beginning of our work we formulated as a general objective, the discovery, analysis, depiction, explanation, and appraisal of land occupancy and use within the metropolitan area. We agreed that discovery, analysis, and depiction of the facts of land utilization should precede explanation and appraisal of these facts, and that probably the most direct and effective way of acquiring many, if not most, of the basic facts was to make, in the field, a map of land utilization. The present paper deals only with the problem of mapping residential areas.

A preliminary reconnaissance into several contrasted residential districts in Chicago raised the question as to whether we should map "forms" or "functions," two terms which many American geographers in recent years have either brazenly courted in the open or shyly loved in secret. Each procedure had its adherents, but we finally agreed that as geographers we were interested both in such facts as the kinds of structures, that is "forms," and in such facts as the density of population to which these structures afford housing, that is, "functions." As we observed one residential district after another, it became clear that the character of each district, whether from the viewpoint of forms or of functions, might be analyzed into a number of individual elements or traits, which in combination or association gave the district its

character or makeup. In mapping, however, even on a large-scale base and in detail, it did not appear feasible to record all of the elements which we were able to distinguish. The question, therefore, was which of these elements should be recorded on the map? As an aid in deciding this question we prepared two lists, one of what we called "form elements," the other of "function elements." The following residential form elements were recognized: areal extent of the individual establishment (building plus grounds), ratio of areal extent of building to that of associated grounds, number of floors or stories in building, type of structure, i.e., single house or apartment building, size of building, materials of construction, quality of construction, age of building, upkeep of building, and upkeep of associated grounds. The general function of all residential structures is to afford dwelling quarters. We analyzed this general function into such elements as the following: affording quarters for unit groups of different sizes (families with several servants, families without servants, single persons), affording quarters for different numbers of persons per unit of ground area, affording quarters for groups differing in luxury demands, and affording quarters for groups differing in the occupation of the breadwinners.

As we observed and listed these so-called "form elements" and "function elements" of residential districts we came to three conclusions: (a) the two sets of characteristics are intimately related, (b) the form elements can be much more quickly and accurately determined by field observation than can the function elements (several of the latter can be ascertained only by going inside the buildings, and some necessitate interviews), and (c) to a high degree, certain of the details of function can be inferred accurately from what can easily be seen of the details of form. On the basis of the last two conclusions we decided to map forms rather than functions.

THE MAPPING SCHEME

A series of experiments in mapping led us to select three form elements for record on the field map: (a) front spacing of buildings, (b) type of structure, and (c) upkeep of buildings and grounds. These three particular form elements were selected because (1) they appeared to constitute the irreducible minimum of readily observable facts necessary to give a clear picture of the manner in which each residential district was occupied, (2) they

seemed to be those form elements from which could be inferred with a high degree of probable accuracy such significant functions as size of unit groups housed, density of population housed per unit of ground area, and standard of living or luxury demands of the population housed, and (3) they appeared to be associated features of residential land occupance closely related in distribution to kinds of sites occupied.

For each of these three form elements we determined through field observation several classes, the number of which we reduced as our study progressed, retaining finally only those classes which seemed to be of primary importance, as follows:

- (a) Front spacing of buildings—three classes
 - (1) Urban spacing—buildings 0 to 50 feet apart
 - (2) Suburban spacing—buildings more than 50 feet apart
 - (3) Subdivisions—buildings on less than one-tenth of the lots
- (b) Type of structure—four classes
 - (1) Small to medium size houses—not more than ten rooms
 - (2) Large houses—more than ten rooms
 - (3) Apartment buildings with not more than six stories
 - (4) Apartment buildings with more than six stories
- (c) Upkeep of buildings and grounds—three classes
 - (1) Excellent
 - (2) Medium to fair
 - (3) Poor

In order that this classification of upkeep be less subjective than commonly is the case, we defined the three classes in terms of readily observable form characteristics, as follows:

- (1) Excellent upkeep—outside parts of buildings calling for regular repair or replacement or attention, such as painted surfaces, roofs, gutters, down spouts, flashings, and brick pointing, in first class condition; grounds also kept in first class condition, with shrubs and flowers which require a good deal of attention.
- (2) Poor upkeep—building in need of outside repairs, replacements, or attention; paint lacking or shabby; grounds untidy and without a lawn.
- (3) Medium to fair upkeep—intermediate between excellent and poor.

In actual field performance, the method of recording observations on the map is a matter of very practical importance. During the earlier stages of our work in Chicago we employed a numerical code to record the form elements of each residential establishment, each of the several digits in a number entered on the map indicating the classification of the particular form element to which it applied. Thus, in the number 221, the left hand digit referred to front spacing of buildings, "2" meaning "suburban spacing," the second digit from the left referred to type of structure, "2" meaning "large house," and the right hand digit referred to upkeep of buildings and grounds, "1" meaning "excellent upkeep" (see list of classes in the penultimate paragraph).

As our work progressed, we abbreviated the map record in two ways. In the first place, as a result of finding that particular kinds of residential establishments in most cases occupied several adjacent blocks, we ceased making a record for each individual establishment, and even to follow every street. Traverses run at least a quarter of a mile apart, with a few offsets, enabled us to determine satisfactorily the character and extent of most residential districts. In the second place, the repeated occurrence of particular kinds of residential areas made possible the recognition of a comparatively small number of types, eleven in all. In recording these types on the map, therefore, we employed a one or two digit number, rather than a three digit number, as follows:

- (1) Large houses with suburban spacing and excellent upkeep
- (2) Medium to small size houses with suburban spacing, medium to fair upkeep
- (3) Large houses with urban spacing and excellent upkeep
- (4) Medium to small size houses with urban spacing and medium to fair upkeep
- (5) Apartment buildings with not more than six stories and excellent upkeep
- (6) Apartment buildings with not more than six stories and medium to fair upkeep
- (7) Apartment buildings with seven or more stories and excellent upkeep
- (8) Mixtures of (3) and (5)
- (9) Mixtures of (4) and (6)
- (10) Houses or apartment buildings, or mixtures thereof, with poor upkeep
- (11) Subdivisions with buildings on less than one-tenth of the lots

We increased the area covered in a given time not only by abbreviating the map record as described above, but also by employing the automobile. With one person to drive the car, and another to map and take notes, the area which could be covered satisfactorily in a day was several times as great as that which could be covered on foot.

During the progress of our work in mapping residential land utilization in Chicago, we experimented not only with various degrees of detail as to the map record, but with base maps of several different scales. We had available the new government topographic sheets on a scale of 1:24,000; with these enlarged photographically four times, we obtained at a low cost (6c per square foot) excellent blue line base maps on a scale of 1:6,000, or about 10½ inches per mile. On this scale we found it possible to record legibly and without difficulty numbers with several digits, as they applied to half or quarter blocks. As a matter of fact, boundaries of each individual plot of ground and of its buildings could be recorded, but the space available for numerical notations, as they might refer to each residential establishment, was hardly sufficient. After we had settled on eleven types of residential occupancy, and a one or two digit record for each, and adopted the plan of generalizing by blocks or groups of blocks, however, we found it possible to put the record on the 1:24,000 base rather than the 1:6,000. This saved the cost of having photographic enlargements made, and meant many fewer square feet of paper to handle and file, but it gave much less space for recording supplementary notes in place on the field sheet.

So far as our study enabled us to determine, the eleven types of residential forms which we mapped differed consistently in certain significant functions. As a matter of fact, these types were set up on the basis of form differences which preliminary study seemed to show were closely related to fundamental function differences, rather than on the basis of form differences merely striking to the eye. It is the opinion of the author of this paper that while the geographer is tremendously interested in landscape, urban as well as rural, he is or should be *selective* in the landscape details with which he concerns himself, and in so far as occupancy forms are involved, he is much concerned with form elements that tie up with functions. In mapping residential occupancy in Chicago we selected form elements which appeared to grow out of, or to be the cause of, or at least to parallel, such functional differences

as, affording housing to unit groups of different sizes, affording housing to populations of different densities per unit ground area involved, and affording housing to groups with different luxury demands.

The production of city maps which show, in some such manner as that suggested above, differentiation in residential occupancy, is in the opinion of the writer well worth the labor involved. Such maps are needed of all the larger cities of the earth, to show the layout, not only of residential occupancy, but also of the several other major types of occupancy, manufactural, commercial, transportational, and recreational. Such maps of cities are needed not only for the present, but back through time, so that we may see what these urban areas were like at different periods in their evolution. Maps of this type afford a sound objective and quantitative factual basis for the understanding of urban land utilization. Geographers cannot depend on workers in the other disciplines, or on public or private organizations, to prepare such maps. These other workers, in so far as they make maps of cities, quite properly direct their efforts to the gathering of data pertinent to their particular problems, and these problems, though they touch those of the geographer at many points, are not the same.

CONDITIONS EXPLAINING LOCALIZATIONS

A well-rounded geographic study of a city calls not only for systematic and effective analytical depiction of the facts of land occupancy and use in written notes and in photographs, as well as on maps, but also for an explanation of this occupancy and use. In the case of our study of Metropolitan Chicago, therefore, we constantly were asking ourselves and the persons we interviewed why the various sections of the city were occupied and used as we found them to be, why there was marked localization of particular types of land occupancy, and whether there were disadvantages inherent in any of the existing localizations. So far as residential areas were concerned, we found that at least four sets of conditions commonly were significant:

- (a) Physical site features, particularly surface configuration, surface drainage, and natural vegetation; subsurface materials, ground water, and soils were in most cases of little significance; we did not try to elaborate the numerical notation system to record such facts on the same map

sheets as that on which we noted occupance forms, but such a scheme appears to be feasible.

- (b) The character of land occupance in adjacent areas, particularly as affecting the attractiveness of the area under consideration; thus, a noisy or dirty factory district adjacent to a residential area decreases the attractiveness of the latter, whereas a park adjacent increases the attractiveness.
- (c) Distance to other sections of the city, and the character of the available transportation connections therewith.
- (d) The character of earlier land occupance in the area.

For each residential district we endeavored to formulate an explanation, in terms of the four groups of factors just enumerated, as to why the area was occupied and used in the particular manner we found it to be. The presentation, however, of this phase of our work is beyond the scope of this paper.

The scheme we employed in mapping residential areas in Chicago may have to be modified as to details, but in general it seems to be an effective method of selecting and recording significant data. Not the least of its virtues is the way in which it compels, at the same time that it facilitates, systematic observation.

Pirovano: Items in the Argentine Pattern of Terrene Occupancy¹

ROBT. S. PLATT

A FRAGMENT OF THE PAMPA

This study has to do with a tract of land in central Argentina—not a community, not a distinct district, not even a well-defined territory, but an undifferentiated fragment of a large region (Fig. 1). The choice of the area of Pirovano for study does not represent a preference for such a fragment instead of a complete unit of human occupancy, but does represent exigencies of field work in a large uninterrupted region of great complexity.

At first glance complexity may seem to be a term unsuited to describe this region, academically called "the Wet Pampa" or, less accurately, "the Pampa;" and noted for its simplicity. The Pirovano tract of land is a nearly flat and entirely undistinguished part of this extensive plain. The fact that it lies near the 100-meter contour line does not distinguish it from the imperceptibly lower land stretching away to the northeast and the imperceptibly higher land to the southwest (Fig. 2). Even the fact that it lies near an apparent divide between interior and exterior drainage areas involves no perceptible contrast, the so-called interior drainage here being only a more complete lack of outflowing surface drainage. Similarly there is nothing critical about the line of 30 inches of average annual rainfall which passes near Pirovano, nor the summer isotherm of 72° F. and the winter isotherm of 49°.

Thus Pirovano is in an area of uniform conditions, not only called simple, but generally called monotonous. Sixty years ago this was grassy pampa, free Indian hunting ground. Today it is no longer "pampa" in the true sense of an unwooded, unfenced, untilled plain. A transformation has taken place since 1875, involving the area in a new and complex pattern of terrace occupancy.

¹This article is based on field work done in March 1930. Acknowledgments are due to Mr. F. B. O'Grady of Buenos Aires and Mr. D. MacDonnell of Coraceros for their hospitality and coöperation.

THE INITIAL WHITE OCCUPANCY

The transformation began with the driving off of the Indians and the distribution of property rights in the land. A tract of 100,000 acres was presented to a surgeon of Buenos Aires named Pirovano (Fig. 3). In form and size this tract befits the general



FIG. 1—Regions of Central Argentina. (Based on Mapa de las Regiones Geográficas, Gastón Federico Tobal, Buenos Aires, 1928.)

setting. The size reflects generous allotment by a nation of abundant unappropriated land and few favored citizens for establishing a rural seat with land for livestock. The form of the property reflects the carrying out of a random system of survey,

begun in the vicinity of Buenos Aires, near the northwest- and southeast-trending shore of the Rio de la Plata, and extended inland to form successive properties of various sizes and convenient rectangular form on the unbroken plain. This orientation of land holdings in the Province of Buenos Aires is suggested by the map of minor political divisions in which generally the boundaries follow property lines (Fig. 4).²

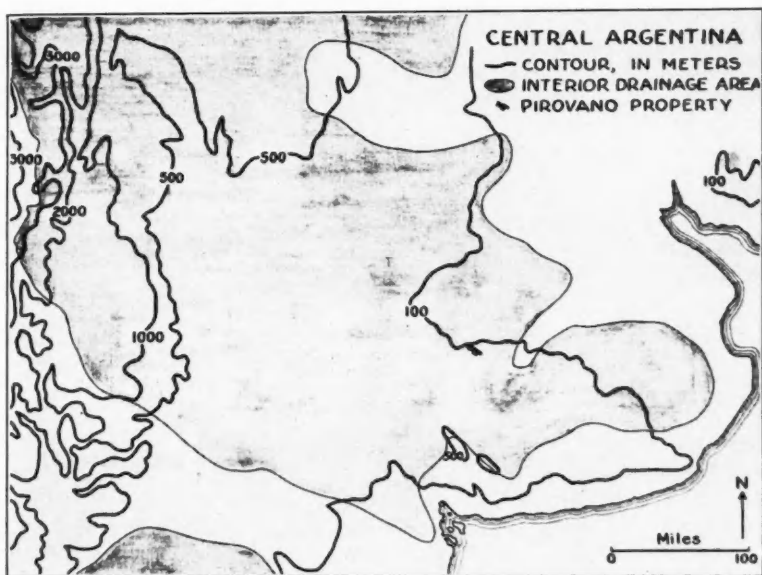


FIG. 2—Elevations and Drainage in Central Argentina. (Based on Mapa Hipométrico, Dirección General de Minas, Geología e Hidrología, Buenos Aires, 1928.)

The property of Dr. Pirovano was used during his life-time in the way intended, the best way practicable before extension of railways to the district. Herds grazed on the unfenced grassland and a house was built as a country residence for the owner, surrounded by newly planted trees on a slight undulation in the plain near the most accessible corner of the property. The pattern of occupancy was still simple in accordance with the simplicity of the natural setting.

²Research in the history of land holding in the province is needed to throw light on the establishment of this orientation.

A PRESENT-DAY CATTLE RANCH

After the death of the first owner in 1906 the property was divided among his four children, a suitable procedure in view of its more than ample size, 25,000 acres for each share. The son received the part containing the original house, and the three

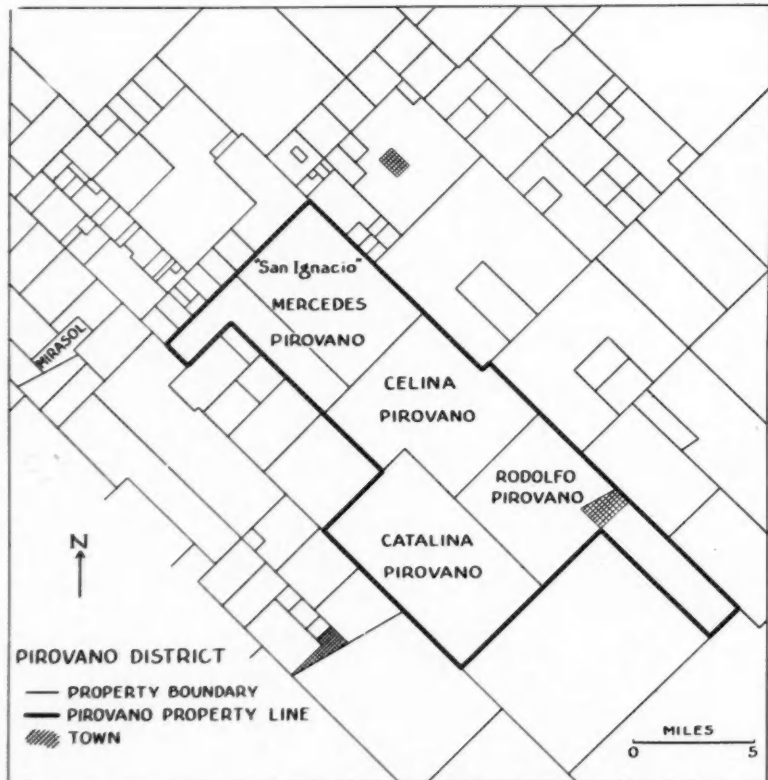


FIG. 3—Ground Plan of Pirovano and Its Surroundings. (Based on Planos Catastrales de los Partidos de la Provincia de Buenos Aires, Gregorio Edelberg, Buenos Aires.)

daughters other parts (Fig. 3). Since the formation of these four units the pattern of occupancy has attained complexity. In all four there have been changes, coincident with developments involving the whole region of grassy plains.

The estancia of Celina Pirovano shows less change than the others. Here cattle still occupy the stage to the practical exclusion of other interests. Yet there is little similarity to the cattle establishment of 25 years ago. Fenced and planted fields have replaced the open grasslands; steers dominantly of Shorthorn blood have replaced the Criole cattle; a group of buildings in a sheltering

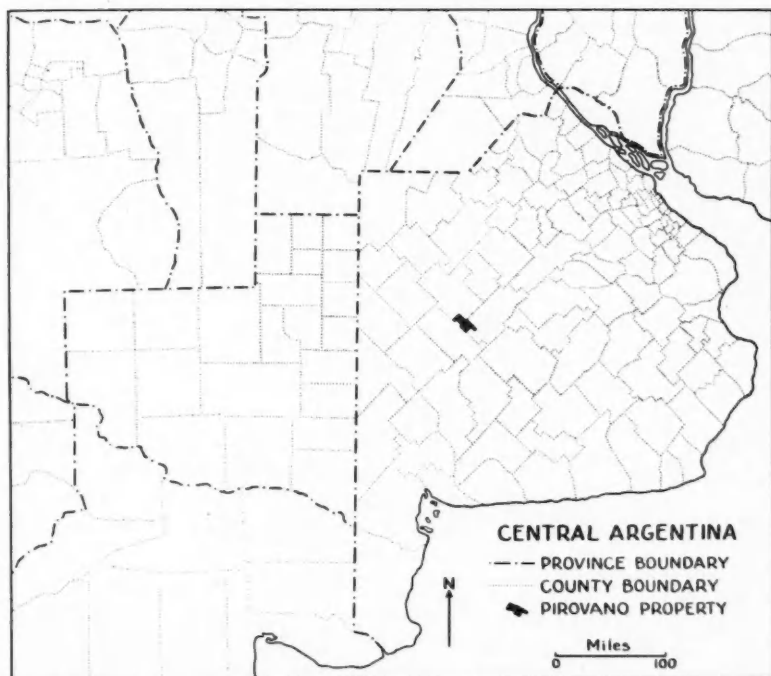


FIG. 4—Pirovano Superposed on a Map of Local Political Boundaries. (Based on maps of Ministerio de Agricultura de la Nación, Buenos Aires.)

grove of trees has become a central focus for the establishment; new transportation facilities and marketing arrangements have drawn the estancia into a regional organization accepting a regional opportunity for export beef production (Figs. 5 and 6).

The pattern of the estancia reflects conformity to the natural setting in the new way. The plain can support better fodder than that afforded by the natural grasses, capable of bringing more cattle more quickly to better condition.

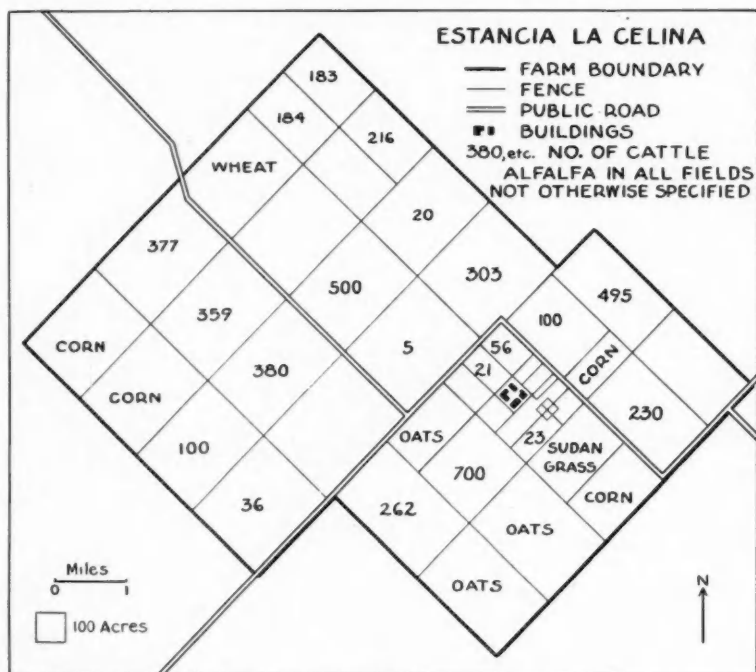


FIG. 5—The Functional Subdivision of Estancia La Celina.

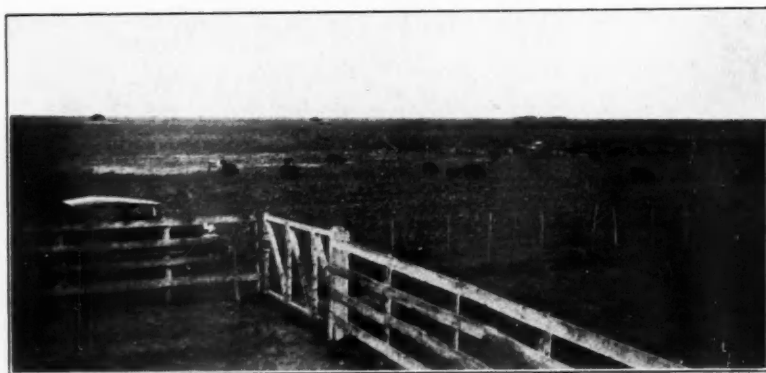


FIG. 6—Estancia La Celina: View from a corral near headquarters. Steers in pasture; fenced and planted fields extending to the horizon.

Planting of fodder and control of herds induces division of the land into fenced fields. The orientation of these fields follows that of the old property division. Their form represents convenient subdivision with a regularity favored by the uniformity of the plain. Their size reflects the use to which the land is put. To avoid an excess of fields and fence lines the divisions are made as large as is consistent with efficient use, for pastures grazed evenly and not neglected in far corners, and for units of cultivation. Accordingly most of the land is in fields of near the maximum size admissible, about 1000 acres. In addition some smaller fields are needed for handling small groups of livestock, particularly around the headquarters of the estancia. There are no streams or lakes and water for each field is provided by a windmill and storage tank.

Of the several crops in the fields alfalfa is the pivotal one, growing luxuriantly in this land with its fertile sandy loam and its ground water within 15 feet of the surface. No other plant available in the district can equal it in economical production of high grade beef. Accordingly alfalfa always occupies most of the fields. But it cannot occupy all the fields all the time for three reasons: first, alfalfa runs out in about 5 years. Therefore, rotation with other crops is needed. Secondly, alfalfa pasture is excellent in the moist mild weather of spring and autumn, but inferior in midwinter cold and midsummer drought. Accordingly, other fodder crops are needed. Thirdly, alfalfa occasionally is killed out by frost or drought and a catch crop is needed.

Therefore some fields are occupied by corn, a good fodder crop and a good successor to alfalfa in rotation; others by oats, good green pasturage in winter and grain fodder thereafter, as well as a suitable successor to alfalfa in rotation; another by Sudan grass, good summer pasturage; and another by wheat, a good grain crop.

Unequal distribution of cattle from field to field is characteristic, on account of variety in the condition of pastures and the requirements of animals. The map (Fig. 5) shows 4640 cattle, less than 1 in 5 acres, fewer than normal, due principally to curtailment at a time of market depression. The capacity is about double this number.

The number is adjusted quite promptly to market and other conditions, since the cycle is short. The estancia is a fattening establishment through which passes a stream of steers, arriving

at two years of age, kept from six to twelve months, and then sent to market. The fodder is so good for fattening that it is not economically used for breeding, and the animals are reared to the fattening stage in grasslands, farther west where the climate is too dry and farther east where the soil is too heavy for alfalfa.

La Celina is efficiently operated and financially successful. The owner, son-in-law of Dr. Pirovano, is a keen business man of Swiss origin.

MODIFIED MODES OF OCCUPANCY

The other three estancias carved from the original property have been in the hands of Argentines—the son of Dr. Pirovano and two sons-in-law. The land is similar, and, at least until re-

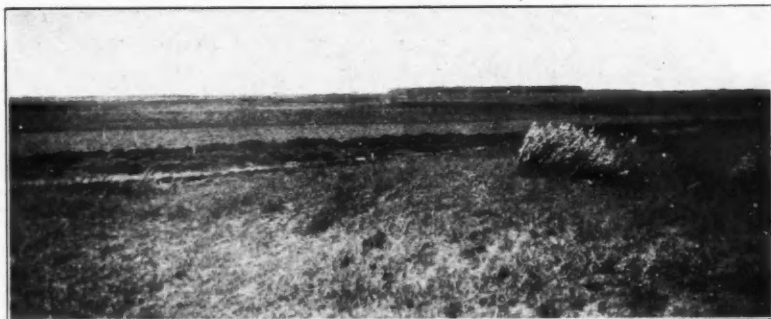


FIG. 7—View in the San Ignacio Property. Taken from a dune covered with wild grasses, across a road and fields of tenant farms in the middle distance, to the "monte," a grove of trees containing the owner's houses, on the horizon in right center. The picture is taken looking southeast from the small "G" on the west side of the diagonal road in Figure 11.

cently, the system of operation has been similar to that of La Celina; but less thrifty control has brought financial difficulties upon all three with attendant changes.

Of these three San Ignacio is the best example of departure from the type represented by La Celina (Fig. 3). After division of the original property 24 years ago the owner of the quarter named San Ignacio selected a site for his house and gardens in his 25,000 acre expanse of treeless plain. The site chosen was a strip of low dunes, not standing out conspicuously but at least offering a slight variety of surface. Another similar dune ridge

which remains unchanged represents the maximum topographic contrast in the district and illustrates the character of the house site (Fig. 7).

In the spot chosen, landscape planting and building have made a fairyland of 250 acres (Figs. 8 and 9). More than 40 kinds



FIG. 8—Dwelling House in the Monte, San Ignacio.

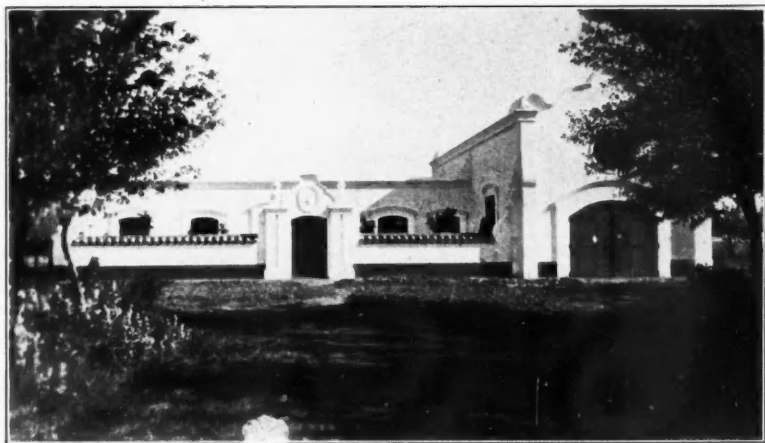


FIG. 9—Blacksmith Shop and Granary in the Monte, San Ignacio.

of trees are thriving here, chiefly middle latitude shade trees, of which common varieties of eucalyptus and poplar have proved most satisfactory; with also a few conifers, and some fruits—figs, peaches, apples, pears, and quinces. For all the trees and shrubs seedlings are raised under irrigation in a nursery and are watered for two years after transplantation.

In the midst of this "monte" woodland, the buildings are more or less hidden from each other—dwellings for the owner, man-

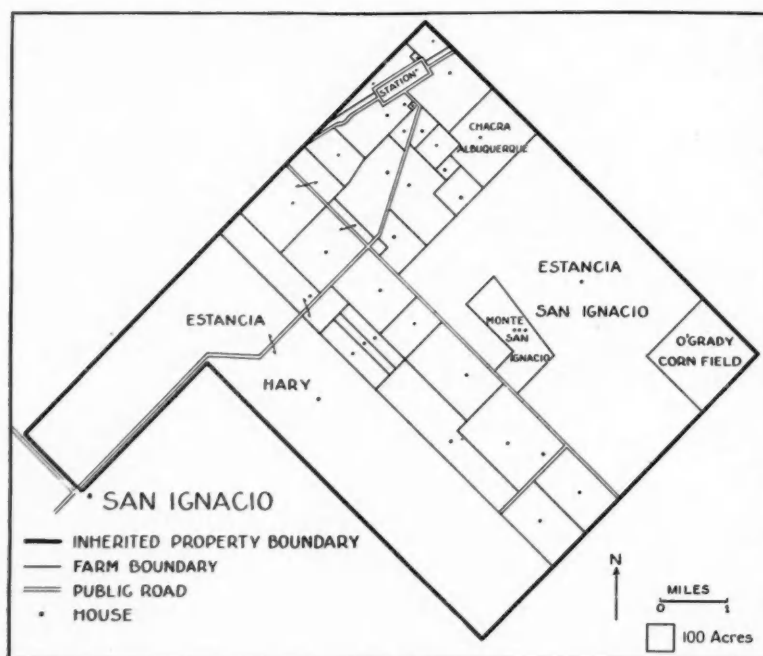


FIG. 10—The Functional Subdivision of Estancia San Ignacio.

ager, caretakers, servants, and field laborers, stables, garage, electric plant, granary, blacksmith shop, chapel, and other buildings; also tennis courts, golf links and swimming pool, all well planned and well kept.

Here the owner's family spends about five weeks during the year, generally in early autumn. They have four other places of residence: a mountain house in Cordova for the spring, a

seashore house at Mar del Plata for the summer, and city houses in Buenos Aires and Paris for the winter.

Their attention has not been centered on the estancia of San Ignacio as a productive enterprise. Luckily for the establishment it has been managed skillfully by a shrewd and honest Scotchman. But financial demands of the owner have exceeded the productive capacity of the estancia. Consequently changes in San Ignacio have extended beyond the exotic group of buildings among the trees to the other 99% of the land of the estancia.

A tract of 8,000 acres has been sold to form the separate Estancia Hary, devoted to alfalfa fields and cattle (Fig. 10). Another tract of 10,000 acres has been divided into 28 small farms, "chacras," rented to tenant farmers.

SMALL FARMS IN THE PATTERN

In their orientation and form the small farms show the same tendencies as the larger divisions, their boundaries drawn to parallel property lines and to form rectangles of miscellaneous sizes (Fig. 10). They are obviously on a smaller scale than either the old property divisions or the modern estancias, reflecting a different sort of land utilization. Here the land is considered primarily not as pasture to which cattle can be brought for fattening but as fertile soil to which labor can be applied for crop production. Even the largest chacra is smaller than individual fields in the estancias. All are within the limits of size suitable for single family agricultural units, from the largest of 700 acres which strains the working capacity of a large family to the smallest of 20 acres which affords a precarious living to one poor worker.

In their turn the chacras are subdivided into fields (Figs. 11 and 12). Unlike the great estancia pastures which seem to occupy the landscape unbounded as far as the eye can see, these smaller divisions are encompassed by a glance and by reason of mere size produce marked contrast in the pattern of occupancy. These fields are less uniform in size than the main subdivisions of the estancias, since small chacras as well as large ones need several field divisions. Accordingly there is a rough conformity between the size of a chacra and the size of its fields; unlike the estancias, in which commonly the total amount of land is so many times greater than the maximum size suitable for fields, that larger

farm area is reflected not in larger but in a greater number of fields.

Even within a single chacra some inequality in size of fields is characteristic, due to unequal space requirements among the uses to which fields are put. Moreover, chacra fields are not permanent enclosures, but are changed from time to time in response to changing needs, by moving the light wire fences, in

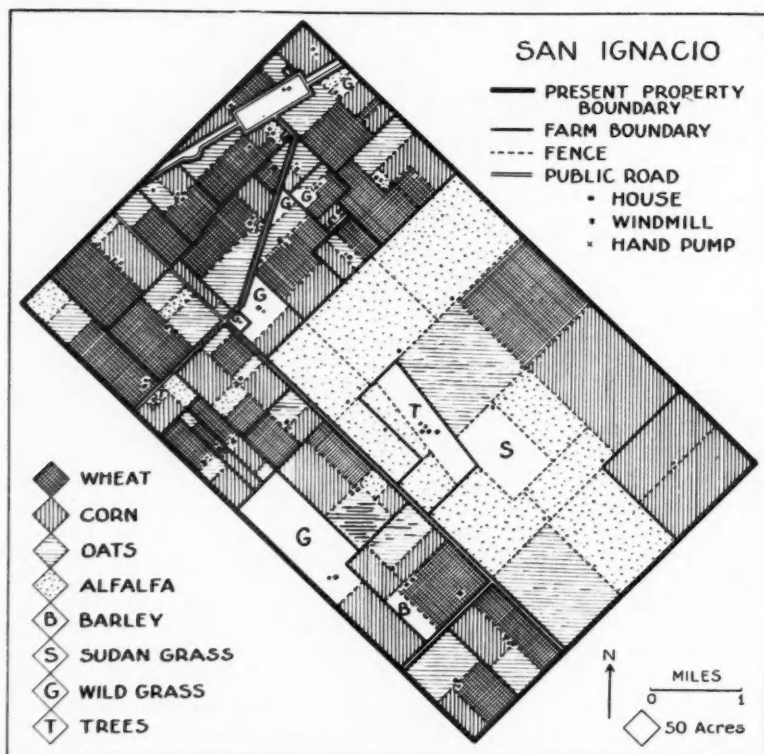


FIG. 11—Crop Distribution on Estancia San Ignacio

contrast with the estancias, where large and similar fields are permanently set off. Nevertheless chacra fields repeat the familiar orientation and rectangular form.

The objective in this subdivision of chacras is to provide for the growing of several crops, partly because some rotation is needed to maintain crop yields, partly because no one crop sup-

plies all needs, and partly because some consideration is given to pasturage for livestock.

Among the crops, wheat is preeminent, occupying 45% of all chacra land, and much of the same land two or three years in

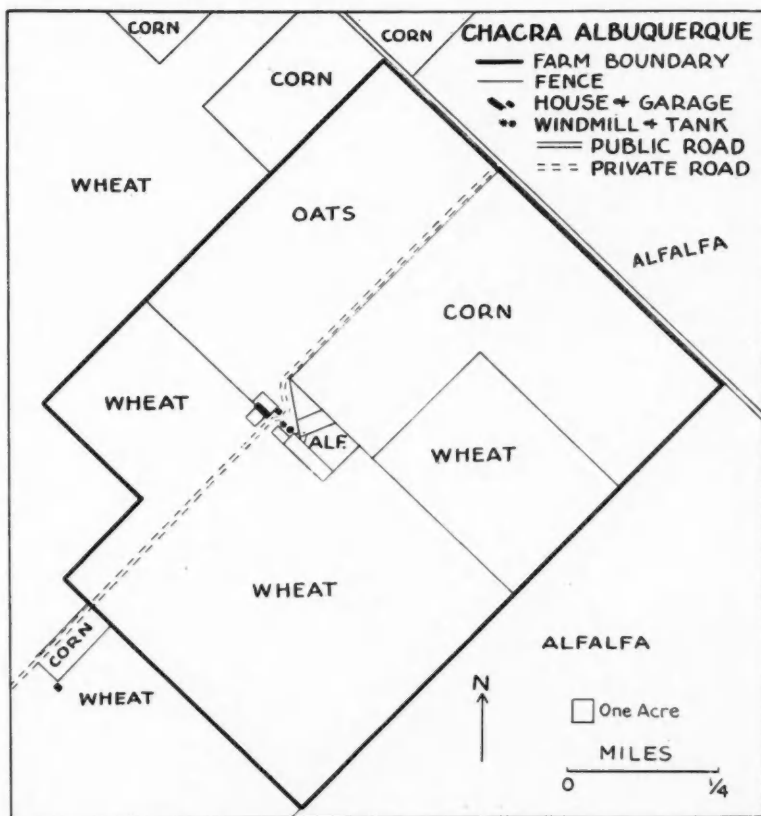


FIG. 12—The Functional Subdivisions of a Chacra. This farm, taken as fairly typical of the chacras, may be identified in Figure 11 by reference to Figure 10. It is one of the larger chacras, having an area of 554 acres. In layout the larger and smaller are generally similar.

succession in spite of smaller yields (Figs. 12 and 13). To a greater degree than any other available crop it combines easy and quick production and marketability, sufficient recommendation

among tenant farmers lacking in capital and operating on a narrow margin of possible earnings and of agricultural knowledge. Straw piles are the most conspicuous features of the landscape.

Along with wheat, oats and corn are included in almost every



FIG. 13—Horses Grazing in Wheat Stubble, Chacra Albuquerque, San Ignacio.



FIG. 14—Harvesting Alfalfa for Seed on a Tenant Farm, San Ignacio. Thresher in right background.

chacra, each occupying about 20% of the land, each planted in irregular rotation with wheat, and each providing grain partly for market and partly for supply. Oats are superior to wheat for winter pasturage and grain fodder and for yield in depleted

soil, but less profitable as a market crop. Corn is superior in its high yield of grain for food and fodder, and fits well into rotation and labor distribution, but is inferior as an export crop, not drying thoroughly in the cool moist autumn as does the corn grown farther north in the adjoining province.

In most of the chacras no other field crop finds a place, although rotation might seem to suggest the desirability of alfalfa. Difference in point of view of the chacra as compared with the estancia is illustrated by the fact that in the few tenant farms where alfalfa occupies more than a barnyard pasture lot it is at least partly in the guise of a grain crop. In these cases alfalfa seed is harvested and finds a good market farther north in warmer parts of the alfalfa region (Fig. 14).

The alfalfa fields belong to exceptionally progressive tenant farmers. Exceptional in another way are a few fields of wild grass which might be thought to be pasture (Fig. 11). But less than in the case of alfalfa do these fields represent a primary interest in livestock. They are evidence of exceptional neglect, perhaps temporary failure to plant a crop, and are practically idle land.

After what has been said of the emphasis on grain farming it may seem surprising that the livestock density per square mile in the chacras is almost as great as that in the estancia. This might be considered contrary evidence on chacra development. But for the most part the livestock represents easy expediency rather than foresighted policy, and is not managed in a way to contribute much to the farm economy.

Horses are most abundant, five times as numerous as cattle (Fig. 13). Some are needed for field work and draft purposes, but the number is in excess of these needs. This results from the fact that horses are obtained easily and breed and increase freely and have no market. Their presence indicates an abundance of incidental fodder—stubble fields, young oats, patches of pasture, and surplus grain—fodder which might possibly be used for marketable animals.

Even the less numerous cattle do not fill a very useful place. Most of them are scrub animals; cows giving little milk and calves growing up slowly to produce inferior meat, eating their full share of fodder.

In the use of livestock two or three chacras are exceptional, not breeding scrub stock but buying and fattening steers for market.

These establishments are among the few which include alfalfa in their system of grain production. They are unusually prosperous, comparable in this respect with La Celina among the estancias.

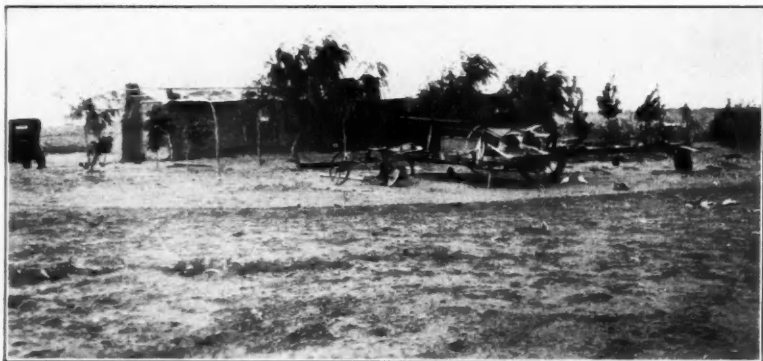


FIG. 15—House of a Tenant Farm, San Ignacio. A mud hut with corrugated iron roof in a patch of thin young shade trees in the midst of fields. The well is beyond the left margin of the picture. There is no other building, no shelter for farm machinery, harvested grain or livestock.

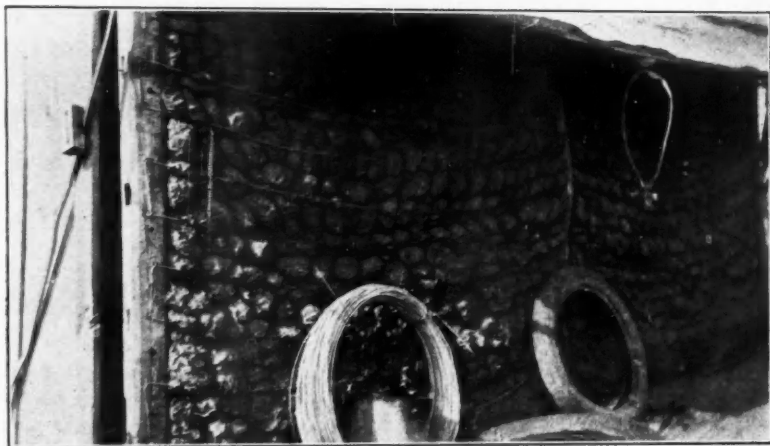


FIG. 16—Unfinished Wall of Mud Ball Construction, Chacra Albuquerque.

The chacra pattern is incomplete without its central focus of activities. Commonly the farm house is in the center of the farm,

without reference to the slight undulations and depressions of the plain, and without reference to bordering roads (Fig. 12). Apparently it is placed with reference to the well which in turn is sunk near the center for convenient access from all quarters at the junction of the several fields. Shallow wells and short wind-mills are favored by wind and water. In all cases the dwelling is an insignificant structure built of mud (Figs. 15 and 16). Around it are corrals, but no other buildings, no shelter for live-stock, or harvested crops, or farm machines. Rain and wind in every season and frost occasionally in winter are not sufficient reasons for large barns even on the estancias, to say nothing of



FIG. 17—The Widow Albuquerque with Son, Daughter, and Hired Man, Chacra Albuquerque. The wall is of mud like that in Figure 16, but with a stucco finish.

the tenant farms. Animals graze throughout the year, bagged grain is covered with canvas, and farm machines stand outdoors.

It is not in buildings but only in machines that there is evidence of capital investment. All the chacras are well equipped with American (U. S.) implements, reflecting needs encountered in new country where small families are tilling large fields and met opportunely by implement sales promotion.

The lack of fixed improvements, and the common lack of foresighted policy in the chacra system are natural accompaniments of temporary land tenure by inexperienced farmers, and high



FIG. 18—Hogs Fattening in O'Grady Cornfield, San Ignacio.

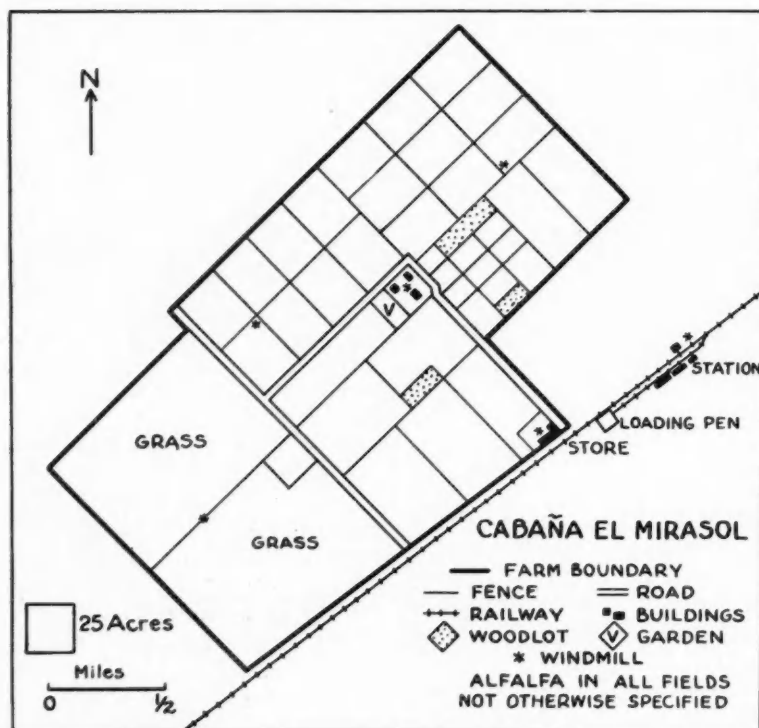


FIG. 19—The Functional Subdivision of Hog Farm, El Mirasol.

expenses with a narrow margin of profit. The people are immigrants, most of them from Spanish Galicia. Land rents and high prices for supplies consume so much of the income from unskillful farming that savings are small and debts are common. It is noteworthy that these farmers and their system fit even tolerably well into the background of their environment (Fig. 17).

The owner of San Ignacio, after disposing of the Estancia Hary and the rented chacras, retained direct control of a tract of 7,000 acres surrounding the monte. This residue has been managed as an estancia like its larger predecessor (Figs. 10 and 11). But continuance of the same financial policy has led to alienation of



FIG. 20—Alfalfa Pastures, Cabaña Mirasol, viewed from the edge of a windmill tank. The sides of the tank are corrugated iron and the bottom mud. Drinking trough at the left, hog shelter in left middle distance, and the manager's house in left background. In center background an alfalfa hay stack, indication of a temporary excess of alfalfa pasturage on the farm.

this residual estancia. An arrangement made this year under bank supervision has left only the monte and a small adjacent field in the hands of the owner, for residence purposes. The bulk of the land, 6,000 acres, has been leased as an estancia to a successful druggist from a nearby town.

THE HOG FARM AS A TYPE OF OCCUPANCY

The last field to be accounted for, 800 acres, has been leased to an American business man of Buenos Aires who owns another farm nearby. He has had the field planted in corn to finish the

fattening of hogs (Figs. 10 and 18). This field is therefore part of another kind of enterprise, a hog farm. The main part of this enterprise is the Cabana Mirasol, of 2,000 acres, formerly part of a cattle establishment, purchased five years ago for development as a hog establishment (Figs. 3, 19 and 20).

The place is a tract in the same plain, similarly oriented and divided. Old fields of cattle-pasture size have been subdivided into fields small enough for controlling swine, separated by tight wire fencing. Two outlying fields containing a strip of low dunes have been left undivided and in wild grass as pasture for the farm horses. All the other fields are in alfalfa, a temporary situation, due to the newness of the establishment. Other crops will succeed



FIG. 21—Sows and Young Pigs in Alfalfa Pasture, Cabaña Mirasol.

alfalfa in a few years. As pasture for swine alfalfa lasts longer than for cattle, due to more reseeding.

The small fields are not all provided with wells, but are supplied by a tank wagon moving between the four windmills and numerous field tanks.

In each of the 20-acre fields there are 25 sows and families of 6 or 7 pigs (Fig. 21). The breeding and fattening of swine belong in the same district, unlike the rearing of beef cattle, in which the long breeding period on grassland belongs in a different district from the short fattening period on alfalfa pasture. Nevertheless, the swine, unlike cattle, require grain in addition to alfalfa for

fattening. Therefore the corn field is leased in San Ignacio and 3,000 hogs fattening there represents the semi-annual output of Mirasol.

Since the farm is a business venture and not a country seat, the central focus contains only a manager's house, laborers' quarters and a small store house.

THE PATTERN OF TRANSPORTATION

The marketing of Mirasol hogs as well as estancia cattle and chacra grain is accomplished through a system of transportation and focal facilities spreading over the region and tying a great area into a unit of commercial production. Interpretation of the intri-

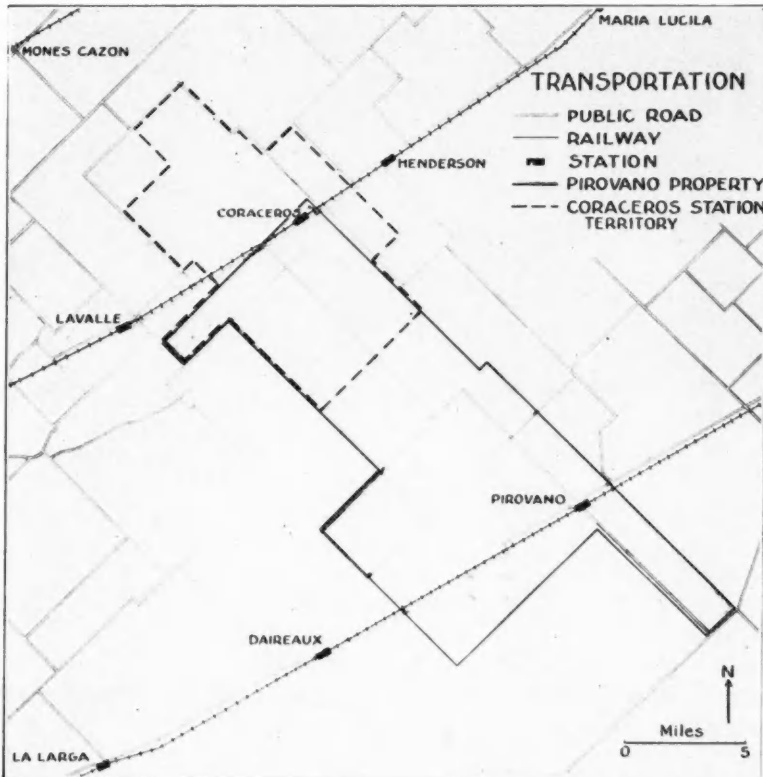


FIG. 22—The Pattern of Transport in the Vicinity of Pirovano.

cate pattern of this system is beyond the scope of this rural study.

Even of the local road pattern little can now be said except that it follows the orientation of property lines and gives access to all of the homogeneous area rather than direct connection between focal points (Fig. 22). The only through roads are those alongside railways, weakly supplementing the through rail lines, which connect the focal points at railway stations with the outside

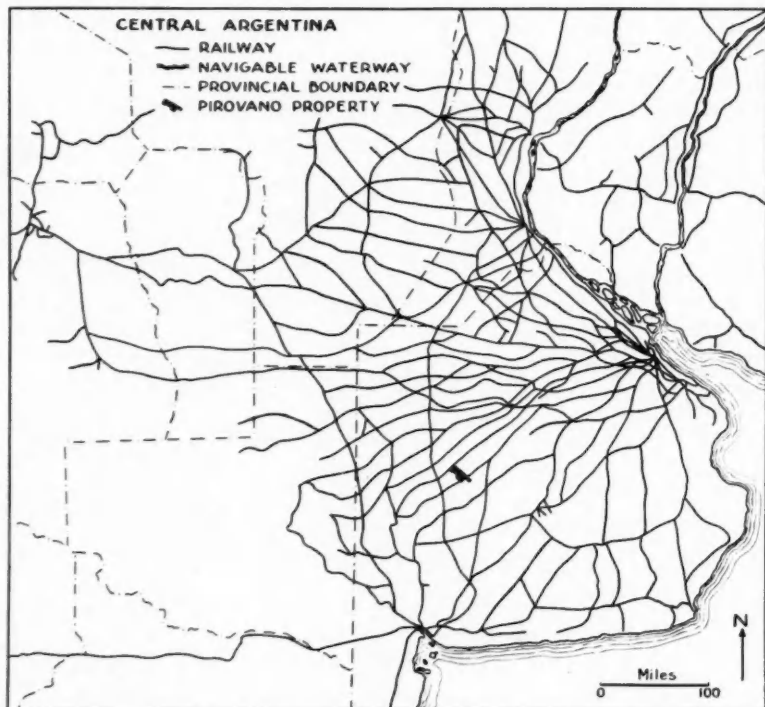


FIG. 23—Pirovano, in the Railway Web of Central Argentina. (Based on Mapa de Ferrocarriles, J. Peuser, Buenos Aires, 1929.)

world. Uniformity of the land and lack of rural concentrations is suggested again by the spacing of railways and the placement of stations regularly 12 miles apart (Fig. 22), with occasional exceptions like the extra station of Coraceros inserted because of private influence at San Ignacio.

The railway pattern of the region suggests again homogeneity

within a certain area, and the function of giving all included districts access to great regional foci (Fig. 23).

Clearly the rural pattern of a small district is complex apart from urban complications and apart from differences from place to place in the so-called Pampa region. The simplicity of the Pampas has vanished. Complexity has been born not only of variety in the land but of uniform richness allowing success in a multitude of ways within a small area. Doubtless the present complexity is unstable: estancias are being subdivided, chacras are temporary.

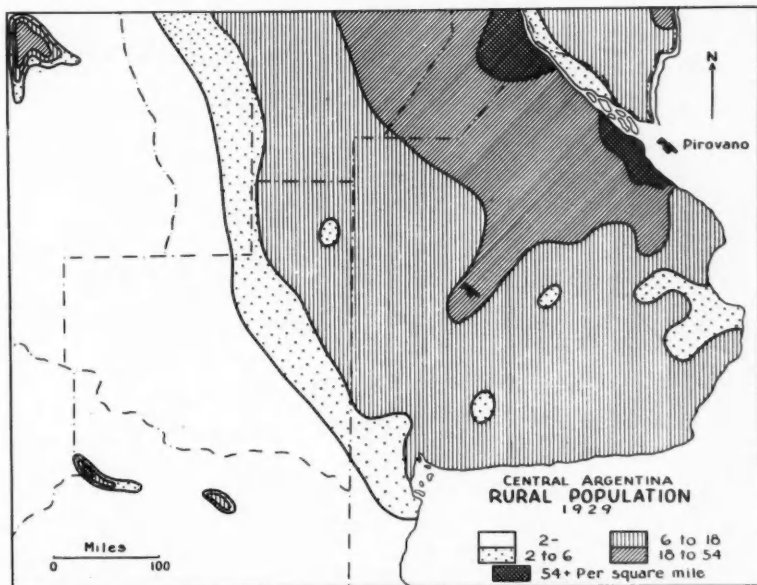


FIG. 24—Rural Population of Central Argentina. The population of cities and towns of more than 4000 is not included.

Perhaps one sort of land use may supersede all present competitors for the land, and uniformity may be established over a large area. Yet this will not be the old simplicity of the Pampas, but a complex uniformity rooted in present intricacies of the pattern of occupancy (Fig. 24).

How simple is the general pattern and how intricate are details of arrangement and movement in the pattern! Is accurate and complete generalization possible until details, which are the basis of true generalization, are understood and interpreted?

